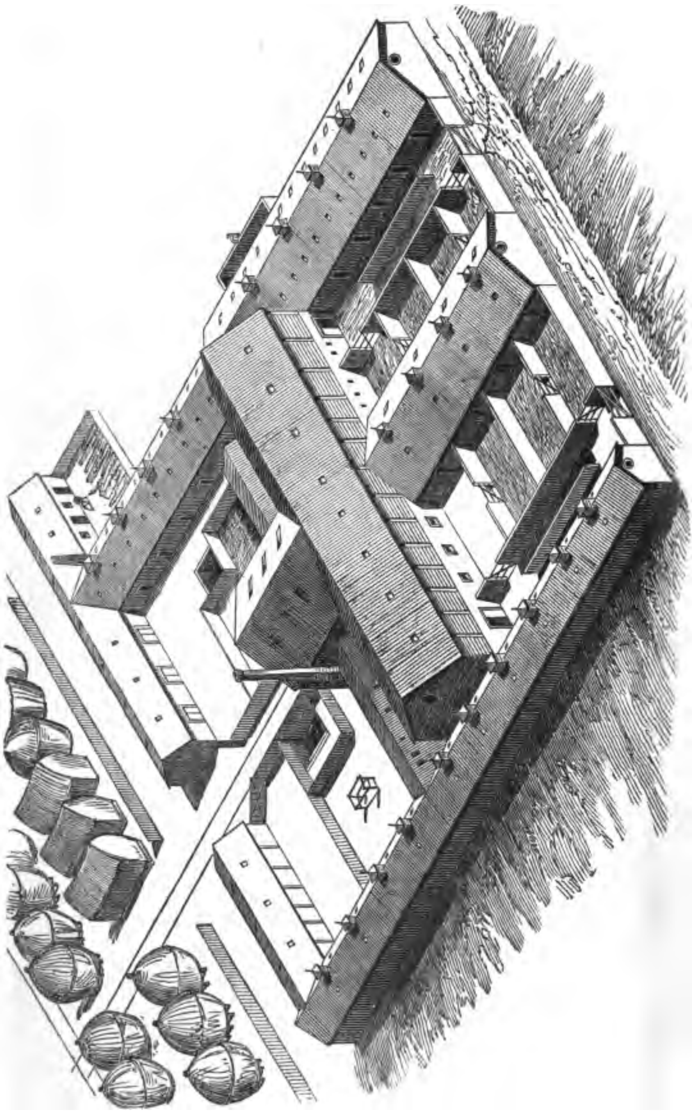

# RUDIMENTARY TREATISE

ON

# AGRICULTURAL ENGINEERING;

**With Illustrations.**

BY

G. H. ANDREWS, C.E.

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# CONTENTS.

## CHAPTER III.

# INTRODUCTION.

THE critical position in which the Agriculturists of this country are now placed, with prices so low as to yield them no return for their year of labour, is surely a time when it is especially necessary to give the most attentive consideration to any matter that may tend to preserve to the landlord the present value of his property, and to the tenant farmer his position in life, and the capital he has embarked in agricultural operations. Although the farmers have been in many cases most unjustly condemned by their political opponents for the manner in which they carry on their business, yet there is one point upon which they are particularly open to censure, and that is, the generally miserable state of the premises and buildings that form their steading.

That they are nearly always antiquated and unfit for the purpose, is a fact that no farmer will deny; and the object the author has in this little book, is to supply him with such necessary data that their reconstruction may be upon the most approved principles. The author having had considerable experience in the erection of agricultural buildings and machinery, and having visited most parts of England, and much of the Continent, with a view to make himself thoroughly acquainted with all that is new and good upon the subject, will endeavour to place before the reader, in the most concise form, the result of his own experience and investigations.

The re-erection of farm buildings is a most important point

to be settled between landlord and tenant. For the latter has a right to demand that he shall be furnished with proper offices suitable for his business, and so arranged that the cost of his labour shall be reduced to the lowest possible point, his stock be preserved in the highest state of health and comfort, and no one particle of his property be wasted or lost, which must be the case if he is without means to preserve the quality and bulk of the whole of his solid and liquid manure.

Until this is done on every farm in England the agriculturists must be considered as in the rear of their rivals, the manufacturers, who economize everything, and leave no stone unturned to discover anything that may facilitate their operations; and scarcely a day passes but something is improved and rendered more perfect. Now this is not the case with the agriculturist; he does know how to improve a thing, and yet does not do it, but leaves it for years in the same inefficient state, and even allows it to wear out, and then reconstructs it in the same manner.

To instance this, are not nine-tenths of the farm steadings in England without gutters to the eaves of their buildings? And does not water from these buildings wash out half the value of the manure? (And I have just seen a set of farm buildings re-erected in Norfolk, where there is a most excellently constructed brick drain made to carry off the liquid manure into the adjoining brook!) Now no farmer could be found who would not condemn this state of things, as being bad; and in no instance is the want of buildings and proper arrangements more conspicuous than in the extraordinary want of care in the preservation of manure always observable in old steadings.

Notwithstanding all farmers know well the value of manure, and that upon the quantity and quality of it depend the amount and value of crop they will get, they never take the smallest precaution to preserve the quality, and seldom the quantity. It is usual to turn the dung out from the

stables and byres into heaps in a yard, which yard always slopes in some direction in which there is a drain, or open outlet, with a constant stream running through,—in wet weather, a full, dark-coloured miniature torrent; and in dry, a sluggish little stream, thick, dark, and brown. This for some reason is generally turned into the horsepond; hence the particularly unwholesome look of the drinking places about old farmeries, appearing as if the farmer was anxious to return a part of his liquid manure into the stomachs of the animals from which it came.

Now, if a farmer, upon receiving the value of his crop at a distant market, found on reaching home that he had been distributing along the way a considerable portion of the coins he had received, through a small hole which he had inadvertently suffered to exist in his pocket, he would be pretty sure, after this discovery, to have this hole immediately mended, to prevent the recurrence of a similar loss. The manure of the farm *is* the farmer's money; for upon his economy in, and judicious management of this, depend the quantity and value of his crops: and it makes very little difference whether you abstract the means of producing a crop, or the value of a crop when produced.

> "For you do take my life,
> When you do take the means whereby I live."—SHAKSPEARE.

That an entirely new, simple, and scientific steading is necessary to most farms, cannot for a moment be doubted. The last fifty years have so entirely changed the system of agriculture in this country, that the crazy and ill-contrived buildings of existing steadings do not afford nearly sufficient accommodation for the farmer to carry on his operations, with the despatch and severe economy now positively necessary. Apparently, want of room would be the last fault to find with the old steadings, for they appear much larger than the new ones; but this arises from the enormous amount of

barn room formerly thought necessary, for besides these huge barns, and a small, ill-ventilated, dark, and therefore always very dirty stable, with an equally wretched cowshed, there is, in reality, no accommodation whatever. Hence we see the agricultural implements, carts, waggons, &c., lying about unprotected from the weather, in whatever place they were last used. The pigs are in the cow byre, the cows are in the piggery, and the whole place knee-deep in water. It will not be an isolated case when you find a farm in this state—it is the rule rather than the exception. All homesteads of the old school partake of it more or less; and that they should remain so is the more remarkable, from the fact that, in other departments of agricultural science, the greatest improvements have been made of late years; for, in every county in England, we find that most extensive and scientific drainages have been, or are being executed. The unwholesome fens and swamps of Cambridge and Lincolnshire have been rendered salubrious and fertile, and the formerly barren sands of Norfolk now produce the richest crops. The great chalk plain of Wiltshire, the name of which was associated with ideas of naked sterility, is now almost a garden. The very sea has been robbed of its bed, the corn grows where the waves broke; and to assist this work, the manure has been fetched from the antipodes.

I must not be understood to say that there are no scientific and efficient farm steadings in England; on the contrary, examples of such are to be found in almost every county: all I intend to assert is, that they are the exception, and not the rule, while in Scotland the reverse is the case—the good being there the rule, and the bad the exception. Indeed, to deny the existence of good steadings in England, would be doing a great injustice to those enlightened noblemen and gentlemen who have spent so much of their time and money in carrying out the most elaborate systems of farm steadings, and who have called to their aid the most scientific and ex-

perienced men of the day, at an outlay from which they can never expect such returns as those who are wise enough to act upon their results, without having to pay such a price as they did for their acquisition.

It is a curious circumstance that farmers should have availed themselves so little of the examples before their eyes, and, what is still more remarkable, I have generally found them averse to these model steadings. This I know to be the case, as I have at all times and opportunities consulted farmers of intelligence and character for success in agricultural pursuits upon this point, with a view to discover their grounds of objection; and the first of these, as may naturally be expected, is the enormous outlay which has generally taken place in erecting them, and in this they are perfectly right; too much money has invariably been spent, consequent, I think, upon the following causes:—First, that the model steading has generally been built upon very small farms, to which it bore no proportion, for I do not think that a perfect steading, constructed upon the most approved principles, and having all the advantages of fixed machinery and steam power, can be applied (to pay) to a lesser farm than one of 400 or 500 acres under the plough; for it happens that the most costly part of the steading would be equally required on a farm of 200 acres—lengthening the stables and cattle sheds would adapt the same steading for 500 acres, inasmuch as machinery must be of certain dimensions to be effective and economical. As to threshing and store barns, I believe they will be made of one size, both on large and small farms; that is, they will be made to contain about one day's work of the machine, and not, as formerly, to house the whole produce of the farm.

Another reason why the farmer does not appreciate model steadings, is his ignorance of the extraordinary saving effected by having the machinery fixed and of superior construction—at least one-third of the power usually consumed is lost in friction and in the want of proper fitting-up in the working

parts. Although advocating a superior description of agricultural machinery and offices, we must not fall into the error which has generally been committed of drawing an ordinary but very unjust parallel between the farmer, employing machinery for facilitating the operations of agriculture, and the manufacturer, who uses the same for the production of the staple manufactures; and it is a common thing for those who make the comparison to complain of the farmer's want of appreciation of good machinery and buildings, because he does not choose to go to the same expense in constructing his premises, and procuring the same high finish in his machinery and working gear as the manufacturer does. For this he has a sufficient reason, for it must be borne in mind that a manufacturer, in constructing his premises, calculates that these premises, and the machinery contained in them, will be constantly occupied and in use,—therefore, in the construction of, say his spinning machine, no expense is spared to get the most beautiful and perfect machine, (the spindle, with its warve and flier, is not less carefully made and highly finished for its purpose, than is the escapement of a watch); and the manufacturer acts wisely in doing so, for this implement is employed from sunrise to sunset, for days, weeks, months, and years, in pulling down and twisting the miles of tiny thread, every inch of which is producing to the manufacturer a minute profit. But the farmer is totally differently situated with regard to *his* machinery, for he only employs his different machines at particular seasons of the year, and then only for a short time. The machine is then laid aside till the recurrence of the season again brings it into use.

Now it is quite evident that a farmer would not be justified in going to the same expense in the construction and fitting up of his machinery, as the manufacturer does; the farmer's being only a producing machine for say one-third of the year, and he not being so dependent upon time as the manufacturer, for when his crop is prepared he has no further use for his ma-

chine till next harvest; whereas every moment of speed gained, and atom of work done additionally, by the manufacturer, is so much increased profit in the year—that portion of his work being finished so much quicker, and the next consequently begun so much sooner. It is in this latter point that he differs so much from the farmer, who, as above stated, however quickly he finishes his portion of work, cannot begin the next similar one until the following year. This is a point that has been very much lost sight of in the construction of what are called model, or example, farms, and hence we see so many attempts injudiciously made to apply the architecture and machinery of the factory to agricultural purposes.

Although it is no part of the object of this book to enter into any discussion respecting the political controversy that now agitates the agricultural world, yet, as the terms high and low farming are constantly occurring, a few words may not be out of place to define the sense in which they are used in this work; for it unfortunately happens that farmers are apt to associate high farming with the practice of those gentlemen, who, having pockets which overflow with wealth derived from other sources, erect the most costly places imaginable, and carry on their agricultural operations regardless of the great question whether it will pay or not, having only one end in view, which is to carry out their designs in the most perfect manner; and practical farmers, having their living to get, know well that if they adopted such practices, they would never *get* a living. Hence what is called high farming is, from this cause, looked at by the farmers with considerable caution. Real high farming consists in developing to the utmost the capabilities of the land, by employing on it as much capital as will effect that purpose; in economizing and preserving every atom of manure; in reducing all expenses of labour, &c., to a minimum, and in increasing the produce, and consequently the profit, to a maximum. This high farming is that which every farmer will soon have to adopt; that is, he

must occupy only as much land as he can cultivate thoroughly well, and if his holding be large and his capital small, he must either increase the latter or diminish the former; for it is quite certain, independent of the question of free trade or protection, that if high farming will not pay, low farming *cannot*.

Supposing a farmer has a quantum of manure, not more than sufficient for one field, it would be a most injudicious proceeding on his part to spread that quantity over two, as he would therefore be paying double the amount of rent, taxes, tithe, &c., of another man who confined his operations to only one field.

Now are not at least two-thirds of the farmers in England following precisely this injudicious line of conduct, by occupying a great deal more land than they make manure for? In other words, farming very low, and losing sight of this important fact, that there are certain constant outgoings common to both a large and small crop grown on the same number of acres. *The farmer therefore who doubles his crops, without increasing his ground, in effect halves those constant expenses, and therefore, by farming high, secures to himself a peculiar source of profit, not available to the low farmer.* Admitting that this principle is true, and that if we are to farm at all we must farm high, both from necessity and principle, we are again brought back to the original subject of farm buildings, which it is the object of this work to describe and discuss.

# CHAPTER I.

## CHOICE OF SITUATION AND ARRANGEMENT OF THE BUILDINGS THAT FORM THE HOMESTEAD.

### CHOICE OF SITUATION FOR ERECTING THE STEADING.

The choosing of the site upon which to build the steading is a very important matter, and requires much more consideration than would at first appear, for if it has been judiciously chosen a vast annual amount of labour may possibly be saved.

Theory would at once point out the centre of the farm as the spot best suited, but the locality (in nearly all cases) will afford some peculiar advantages that will settle the question; for instance, if water power can possibly be obtained, either from the natural fall of any river, or from the penning up of any little brook, or from the drainage of the land (as has been done in some cases), then it ought to decide the position of the steading at once, as there is scarcely any advantage that can equal a motive power from a natural fall of water, not that an inconvenient spot in other respects should be fixed on, merely because the fall happens to be there, as there are many simple contrivances of engineering for carrying the fall of water to the mill, if it is inconvenient to take the mill to the water.

Facility of access to the turnpike road, or proximity to a railway station, or canal wharf, or the opportunity to discharge the liquid manure from the tanks to some distant spot on the farm by its own gravity, and so avoid the great labour of pumping: all these, and others, are circumstances that will affect the choosing of a site.

But there are certain desiderata that must be sought, and had under all circumstances, such as a tolerably level piece

of ground, or one gently sloping towards the south; this must be perfectly dry, or be artificially made so. Proximity to marshes, ponds of stagnant water, or sluggish rivers, should be avoided; and a plentiful supply of good water must be at hand, and the means exist for procuring an efficient drainage of all the water from above, or from the adjacent land.

If the steading be placed on a bed of gravel, or sand, it will be an advantage.

Having enumerated the chief points to be attended to in the choice of the site, we must next consider the most judicious arrangement of the buildings, yards, &c., that form the homestead of the farm.

The homestead, or onstead, consists of the dwelling-house of the farmer, with the buildings and premises attached, and used by him in carrying on the various operations in his business requiring sheltered or enclosed offices. Scotch writers upon agricultural subjects generally use the word steading, in reference to all the offices required for the rearing and fattening of stock, and preparation of crops, and other produce of the farm for market, in which sense it is used throughout this book.

The buildings and offices necessary for a perfect steading on a mixed husbandry farm, will consist of—

Rick Yard.
Straw Yard.
Threshing Barn.
Granary.
Stables.
Fatting Sheds.
Cow Byres.
Sheep Shed.
Cattle Courts.
Calf Pen.
Piggery.
Chaff House.
Root Stores.
Turnip House.
Washing House.
Boiling House.
Boiler House.
Fuel House.
Engine House.
Implement House.
Cart Lodge.
Dung House.
Manure House.
Manure Tanks.
Wool Room.
Shepherd's Room.
Poultry House and Yard.
Infirmary.
Hammels.
Bulls' Hammels.
Dairy.
Cheese Room.
Tool House.
Farmer's Residence.
Carpenter's Shop.
Smithy.

Besides these offices there are other subsidiary buildings required that are not included in the above list, which form what is called the homestead, but will be found treated of under a separate head.

Having chosen the site of the proposed steading, the next step is to construct the most judicious form of ground plan, and this point is deserving of the most serious consideration.

It is a point to which all eminent agriculturists have devoted much of their attention, and the result of their study is, that no fixed form of ground plan will apply equally well to all descriptions of farms, or to all localities; but there are certain fixed principles equally applicable to all, and those principles ought to govern the arrangement of any plan in any locality. It will, therefore, be wise here to consult the opinion of the first authorities who have written upon the subject.

Mr. Stephens (the author of one of the most complete, elaborate, and valuable works in the English language, in "The Book of the Farm," treats of the subject of homesteads at great length, and, with the same care that he has bestowed upon every department of the noble science of agriculture), lays down the following principles, to be kept in view in designing the steading.

"(5.) The leading *principle* on which these arrangements are determined is very simple, and it is this:—

"1. Straw, being the bulkiest article on the farm, and in daily use by every kind of live stock, and having to be carried and distributed in small quantities by bodily labour, though a heavy and unwieldy substance, should be centrically placed, in regard to all the stock, and at a short distance from their respective apartments. The position of its receptacle, the *straw barn*, should thus occupy a central point of the steading; and the several apartments containing the live stock should be placed equidistant from the straw barn, to save labour in carrying of straw to the stock. 2. Again applying the prin-

ciple that so bulky and heavy an article as straw should in all circumstances be moved to short distances, and not at all, if possible, from any other apartment but the straw barn, the *threshing machine,* which deprives the straw of its grain, should be so placed as at once to throw the straw into the straw barn. And, in further application of the same principle, the *stack yard,* containing the unthreshed straw with its corn, should be placed contiguous to the threshing machine. Lastly, the passage of straw from the stack yard to the straw barn, through the threshing machine, being directly progressive, it is not an immaterial consideration in the saving of time to place the stack yard, threshing mill, and straw barn, in a right line.

"(6.) Different classes of stock require different quantities of straw to maintain them in the same degree of cleanliness and condition. *Those classes* which require the *most* should, therefore, be placed *nearest* the *straw barn.* 1. The younger stock requiring most straw, the courts which they occupy should be placed contiguous to the straw barn; and this can be most effectually done by placing the straw barn so as a court may be placed on each side of it. 2. The older or fattening cattle, requiring after the young stock the largest quantity of straw, the hammels which they occupy should be placed next in propinquity to the straw barn. 3. Horses in the stables, and cows in the byres, requiring the smallest quantity of straw, the stables and byres may be placed the farthest in distance from the straw barn. The relative positions of these apartments are thus determined by the comparative use of the straw. 4. There are two apartments of the steading whose positions are necessarily determined by that of the threshing machine—the one is the upper barn or threshing barn, which contains the unthreshed corn from the stack yard ready for threshing by the mill; and the other the corn barn, which is below the mill, and receives the corn immediately after its separation from the

straw by the mill to be cleaned for market. 5. It is a great convenience to have the granaries in direct communication with the corn barn, to save the labour of carrying the clean corn to a distance when laid up for future use. To confine the space occupied by the steading on the ground as much as practicable for utility, and at the same time ensure the good condition of the grain, and especially this latter advantage, the granaries should always be elevated above the ground, and their floors then form convenient roofs for either cattle or cart sheds. 6. The elevation which granaries give to the building, should be taken advantage of to shelter the cattle courts from the north wind in winter; and for the same reason that shelter is cherished for warmth to the cattle, all the cattle courts should always be open to the sun. The courts being thus open to the south, and the granaries forming a screen from the north, it follows that the granaries should stretch east and west on the north side of the courts, and it has been shown that the cattle courts should be placed one on each side of the straw barn; it also follows that the straw barn, to be out of the way of screening the sun from the courts, should stand north and south, or at right angles to the south of the granaries. 7. The fixing of the straw barn to the southward of the granaries, and, of course, to that of the threshing machine, necessarily fixes the position of the stack yard to the north of both. Its northern position is highly favourable to the preservation of the corn in the stacks. 8. The relative positions of these apartments are very differently arranged from this in many existing steadings; but I may safely assert, that the greater the deviation from the principle inculcated in paragraphs (5) and (6) in the construction of steadings, the less desirable they become as habitations for live stock in winter."

I have not been able to discover, on looking over nearly all that has been written upon the subject, anything so clear, or any advice so judicious, as that here given by Mr. Stephens;

in fact, I observe that most of those who have written upon the subject, since the publication of his "Book of the Farm," have adopted his ideas, and often his language, and that, too, without acknowledging from whence they obtained it.

But although I place such great value upon Mr. Stephens's advice up to this point, I do not follow him any further in the carrying out of his details, or the accommodation for each particular head of stock. His plan may be right for the Scotch system of agriculture, but certainly it is not the most judicious for England, especially for the southern counties. The chief objection I have to it is its immense cost; and I am inclined to think that it is only fit for the good old times of high prices, and that we must look in another direction for assistance in the present hour of need (when a quarter of wheat only fetches 36*s.*, and the markets falling), for something cheap; in fact, such a one as a landlord will not mind erecting, and a tenant can afford to pay for: and if cheapness is the object, we cannot do better than look to Mr. John Caird of Baldoon, who gives us a design for a farmery,* embracing all the valuable improvements imported from Auchness, and capable of accommodating 10 horses and 80 head of cattle in stalls, besides implement house, barn, granary, straw and chaff house, clover and turnip house, boiling house, covered dung house, and tank for saving liquid manure, pig and poultry houses, all for 612*l.* This amount of accommodation for such a sum would be, indeed, a saving, as I know of no steading of the same size that has been erected for any-

* The principal difference between the Scotch plan of constructing farm steadings and the English is, that in the former the greater part of the stock are kept in hammels, which are small sheds with yards attached, containing one or several heads of stock; this necessarily causes a much larger quantity of walling, and consequently the cost of the steading is much increased. In England a system of continuous undivided sheds has been adopted instead, and no disadvantage has arisen in consequence that would at all justify the extra expense incurred in the former plan.

thing like the sum; for about 1000*l.* to 1500*l.*, is the usual cost of such sized farmeries when constructed with good materials, workmanship, and in an economical manner—unless some unusually cheap local material is at hand—I am inclined, then, to think that Mr. Caird has under-estimated the cost considerably, or, that he was alluding to particular localities in Ireland; but the latter cannot be the case, as he makes a direct comparison between his own design and that of architects generally, Mr. Stevens and others, and undertakes to save one-third. I have taken the trouble to extract the quantities with considerable care, and moneying them out at the lowest prices I know of work being done for.

The cost of erection stands thus:—

| | | £ | s. | d. |
|---|---|---|---|---|
| 171 cubic yards of excavation to foundations and tank, | at 4*d*. | 2 | 17 | 0 |
| 46 rods reduced brickwork . . | at 8*l*. 10*s*. | 391 | 0 | 0 |
| 127½ square Countess slating . . . | at 21*s*. | 133 | 17 | 6 |
| 510 run of ridge tiles . . . . | at 2*d*. | 4 | 5 | 0 |
| 517 superficial yds. of paving to cattle houses and stable, | at 1*s*. | 25 | 17 | 0 |
| 1287 cubic feet timber in rafters, joists, &c., sawn, | at 1*s*. 6*d*. | 96 | 10 | 6 |
| 227 cubic feet timber wrought stall posts, &c. | at 1*s*. 9*d*. | 19 | 7 | 3 |
| Manger complete and fixed | at per foot run, 1*s*. 6*d*. | 4 | 2 | 6 |
| 127½ square slate laths . . | at 7*s*. 6*d*. | 47 | 16 | 3 |
| 31½ square barn and granary flooring, 1½ thick | at 30*s*. | 47 | 5 | 0 |
| 4 square 1-inch flooring . . | at 26*s*. | 5 | 4 | 0 |
| 551 superficial 1-inch ledged door . | at 4*d*. | 9 | 3 | 8 |
| 750 superficial 1½ wrought boarding between stalls, and to form straw-cutting room . . | at 5*d*. | 15 | 12 | 6 |
| 50 run of hay rack . . . | at 1*s*. | 2 | 10 | 0 |
| 75 superficial yds. of render in cement to inside of tank, | at 8*d*. | 2 | 10 | 0 |
| 30 superficial yards of tile paving to feeding troughs, | at 2*s*. 6*d*. | 3 | 15 | 0 |
| 21 cwt. 1 qr. 15 lbs. of 5 lb. milled lead in valleys, gutters, &c. | at 23*s*. 4*d*. | 24 | 18 | 11½ |
| 84 superficial of sashes, glazed . . | at 1*s*. 6*d*. | 6 | 6 | 0 |
| | | £841 | 18 | 1½ |

Eight hundred and forty-one pounds, then, is the cost

of Mr. Caird's farmery, erected in the most economical manner; but in what state is this steading after this amount has been expended upon it? Why, not in any way complete or fitted for occupancy; for the yards are unpaved and unformed, the clay, or whatever soil the erection might be placed upon, is in the state it was when last used, which might have been as an arable field. There are no gutters to any of the buildings, or rain-water pipes, or water drains to carry it clear of the manure tank. The whole of the exterior wood work is unpainted, and there are no boundary fences or gates to the yards, and scarcely any fixtures of any kind, but the mere shell of a place—undrained, unpainted, and unenclosed. Let us finish it, then, and add to the former outlay of 970*l.* the necessary works required to make it tenable, and which consist of the following, viz.:—

| | | £ | *s.* | *d.* |
|---|---|---|---|---|
| ½ rod superficial reduced brickwork to rain-water tank, | at 8*l.* 10*s.* | 4 | 5 | 0 |
| 15½ yards superficial render in cement to ditto . | at 8*d.* | 0 | 10 | 4 |
| 60 feet run inch lead pipe, to supply in bullock sheds | at 6*d.* | 1 | 10 | 0 |
| 2 ¾ draw-off cocks . . . | at 2*s.* | 0 | 4 | 0 |
| 230 yards run 3-inch eaves guttering . . | at 3*d.* | 2 | 17 | 6 |
| 40 yards run 2-inch iron rain-water pipe . . | at 5*d.* | 0 | 16 | 8 |
| No. 12 heads at 1*s.* 10*d.*, 12 shoes at 1*s.* . | | 1 | 14 | 0 |
| 167 yards run drain from ditto under ground . | at 1*s.* | 8 | 7 | 0 |
| 900 yards superficial paving and forming to yards | at 1*s.* | 45 | 0 | 0 |
| 76 superficial 3-inch sills to doors . . | at 7*d.* | 2 | 4 | 4 |
| 158 yards superficial painting in 3 oils to buildings | at 6*d.* | 3 | 19 | 0 |
| 77 yards superficial painting in 3 oils to guttering | at 6*d.* | 1 | 18 | 6 |
| No. 12 heads at 6*d.*, 12 shoes at 6*d.* . . | | 0 | 12 | 0 |
| 2¾ rods superficial reduced brickwork to boundary walls, | at 8*l.* 10*s.* | 23 | 7 | 6 |
| 60 feet superficial 1½-inch gates to yard . . | at 1*s.* | 3 | 0 | 0 |
| 2 oak gate-posts . . . . . | at 5*s.* | 0 | 10 | 0 |
| 2 pair of hooks and bands to ditto . . . | at 2*s.* | 0 | 4 | 0 |
| 14 yards superficial painting in 3 oils to ditto . | at 6*d.* | 0 | 7 | 0 |
| 581 yards superficial twice lime-white to walls . | at 1*d.* | 2 | 8 | 5 |
| | | £100 | 6 | 3 |

We have now, then, 100*l.* 6*s.* to add to the former estimate of 841*l.* 18*s.* 1½*d.*, which brings the cost of the steading up to 942*l.* 4*s.* 4½*d.*, which is exceedingly low for the large amount of accommodation; it is evident, then, that the form of this ground plan is an excellent one, as might be expected from Mr. Caird's practical knowledge of his profession, and his having had the benefit of the assistance of Mr. M'Cullock, of the celebrated farm of Auchness. I considered it of importance to give an engraving of this ground plan, but was not so fortunate as to obtain Mr. Caird's permission. A leading feature in the Auchness farm, and adopted here, is the having a covered dung-house, which Mr. Caird describes as unquestionably the most important part of the whole steading, yet in the judges' report of the Prize Essays of the Royal Agricultural Society, after carefully considering the subject, they arrived at the conclusion that covered dung-houses are not always desirable.

## PRIZE ESSAYS AND PLANS OF THE ROYAL AGRICULTURAL SOCIETY.

The Royal Agricultural Society of England, last year, offered a prize for the best essay on agricultural buildings, and it was awarded to Sir J. Tancred, Bart.

The essay, plan, and details, are published in the Society's Journal, with others, by Mr. J. Ewart, Mr. C. Spooner, architect, and John Elliott, farmer; also by John Hudson, Castle Acre, by Thomas Sturgess, surveyor, of Bedale, Yorkshire, and some valuable remarks by C. D. Tebbutt, engineer: the whole forming the most valuable mass of practical information upon this important subject that has hitherto appeared in print; and persons about to construct or improve existing farmeries, would do well to consult these valuable data.

The design of Sir J. Tancred is laid out in the form of a square, and consists of three parallel ranges of buildings running north and south, with others transversely on the

north side, and sheep house, piggeries, and horse boxes detached.

The steading accommodates 50 bullocks, 10 horses, with calf pens, piggery, sheep shed, ample barn room, workshops, a manure depôt (not covered), and every accommodation that can possibly be required for carrying on the business of the farm in the most economical and approved manner.

The total cost of the whole, exclusive of builder's profit, and not including machinery of any kind, is estimated at 1019*l.* 1*s.* 8¾*d.*

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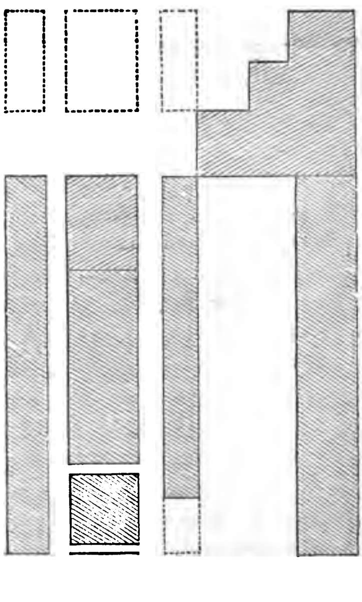
Block Plan *of a Design for Steading, by* J. Ewart, Esq.

*Fig.* 1.



Mr. Ewart's design is thus arranged (and is I think one of the best I have ever seen):—It consists of four parallel lines of cattle boxes, an open yard 30 feet wide, and a line of stabling all parallel to each other, and running north and south.

The boiling house is on the north end, and in the centre of the lines of cattle sheds, and the threshing and straw barns on the north-west extremity of the whole. This plan is capable of very considerable extension, without in any degree impairing the usefulness of any of the original buildings for the purpose for which they were designed, which is a very important point to be attended to in designing the ground plan of a new homestead. The accommodation consists of

Barn of two stories.
Straw barn or fodder house, with a granary above it on a second story.
Engine room, and shed for engine boiler.
Stabling for 8 horses.
Two loose boxes for stallions, brood mares, or sick horses.
Receptacle for stable dung.
Shed for implements.
Turnip house, fitted with steam apparatus.
Cattle lairs in a double range for 12 fattening beasts.
Cowhouse for 8 cows.
A single range of cattle lairs for 12 beasts.
Ditto for 8 beasts.
Calf house.
Liquid manure tank, to which the moisture of the stables, cowhouse, and calf-house may be conducted by covered drains.
Open yard, 30 feet wide, and
A watering trough.

The estimated cost of this steading is £1166 16*s.* 10*d.* In the same essay are also data of a plan of Lintz Hall farm, near Tanfield, in the county of Durham, and some valuable details of the construction of cattle boxes, &c., well worthy of attention.

The third plan is the joint production of an architect and a practical farmer, Messrs. J. Elliott and W. Spooner, and, as might be expected, a most excellent design is the result of their labours. A large straw and threshing barn is placed at the north side of a square; the sides, and a considerable portion of the centre are occupied by the accommodation

for stock, consisting of loose boxes for bullocks, a lambing house, stables, with implement house, artificial manure house, shed for carts and waggons, and a large covered dung pit, which occupies a portion of the south side of the quadrangle. Down the centre are arranged lines of fatting sheds; between these sheds are two lines of railway, joining at the north end, and being in single line through the centre of the barn, when they again diverge to the east and west through the rick-yard. The plan of this railway is most excellent, as the whole of the manure may be removed direct from the cattle boxes, and, as it is continued up to the dung-pit, by this means it would be a most economical manner of removing so weighty an article as manure. The adaptation of railways in economizing farm labour is a very important point, deserving of great consideration; and a great deal of ingenuity is displayed in this design. Its use is thus described by the author: When the cattle are to be fed, the trucks take up their load of roots, cut or boiled, in the root boiling or cutting store, or the chaff and linseed compound for another meal, obtained each from their respective storehouses adjoining the rail, and proceed on their way through the cattle boxes, giving out to each animal its appointed allowance.

The trucks are again available for littering the animals, procuring the supply from the straw barn; and when the accumulation of manure in the boxes has reached its limited height of increase, the trucks convey the mass of dung direct to the dung pit. One man could then easily, by means of the rail and truck, manage all these operations in a short time, so that the whole of the animals might receive their food with regularity. Even if the railway be not adopted, such an arrangement of building as we have shown would afford great facilities for feeding and littering the stock; the inclined plane from the various store-houses through the cattle boxes may be still retained, and if a plank were laid down, and securely fixed in the centre of the passages between the feeding boxes, a man

would be able to take a good load on a long-frame wheelbarrow; the expense of laying down such planks would not exceed 10*l.*

The accommodation in this steading is for 14 horses, 50 bullocks and cows, with calf pens, sheep shed and piggery, besides corn and straw barns, lambing house, boiling house, &c. &c., and the estimated cost is 1438*l.* 16*s.* 5*d.*

They proposed to construct the whole of the walling with hollow tubes of baked clay. They say that, through the kindness of the Duke of Richmond, the opportunity was recently afforded them of making a practical trial of this method of construction; and, from experience, feel no hesitation in pledging themselves that, with ample strength and equal durability, as compared with common brick walls, their method of construction with these hollow tubes will effect a saving of one-third in the cost per rod in walling.

The next plan is by a practical farmer, Mr. J. Hudson, of Castle Acre, and is on a different principle to those before mentioned, as in this design ample accommodation is provided for stock in enclosed yards, while in the former ones the principle has been to almost entirely dispense with the stack-yard, and place the whole of the stock in boxes or stalls; the two methods have both certain peculiar advantages, which will be more or less adopted as the situation and system of farming require. Mr. Hudson's ground plan is in the form of a parallelogram, lying lengthwise, east and west. On the north side are four yards, 64 feet square, including the sheds, which are 16 feet square, open fronted, and supported by wooden posts set upon stone. On the south side are the cart house, stables, and cart sheds, with granaries over, gig house, fowl house, cooking house, &c.

The buildings to be built with bricks and covered with slates; roofs, &c., Memel timber; oak jambs, posts, &c.; stone bottoms to the story posts of lodges and sheds.

All the yards and buildings to be drained, and the water

carried off by a common sewer* into a reservoir for liquid manure.

The yards to be laid with a fall from each side to the centre to a tank, with grating thereon.

The piggeries to be partitioned into folds, with paved floors; bull and cow houses, and calves' pen, to be paved and fitted up with stalls and feeding manger.

The sheds in cow and cattle yards to be fitted up with feeding cribs. The story posts to stand on brick or stone bases. Cart shed, story posts standing on stone bottoms. Granary to be made over the waggon lodge in roof, 14 feet wide. Cart-horse stable to be made with six loose boxes in each, to be fitted up with iron mangers, rack, and water trough, to be fed at the head. The stores to be kept in corn house, with granary over the same.

The riding stable to be fitted with two stalls and one loose box.

The barn to be built with two floors; the first floor to be of brick, and the second floor to be boarded for threshing and dressing corn, &c.; the threshing to be done by machinery, worked by steam or horse power.

Estimated expense, 1500*l.*

The fifth plan is by Mr. Sturgess, and is arranged in the form of a parallelogram, having the straw barn, threshing barn, &c., placed on the south side; and four lines of buildings, lying north and south, between which are ample fold yards. All the necessary offices are provided and well arranged; there is no striking peculiarity distinguishing this from the others, unless it be, that it partakes somewhat of the plan of Mr. Hudson and the other three combined; that is, the accommodation is divided between fatting boxes or stalls, and folding in yards,—Mr. Hudson having no beasts in boxes, and the former plans being designed specially for feeding in boxes, with little accommoda-

* This must surely be an error in the Journal.

tion for stock in yards. Besides these plans are some remarks on agricultural buildings by Mr. Tebbutt, well worthy of perusal.

The information contained in these essays is decidedly deserving of the most attentive consideration, as it embodies the opinions of some of the most eminent agriculturists of the day, and all the writers are practical men, intimately acquainted with the most approved methods practised in the different counties of England, as well as the particular locality from which they write.

The value of the essays is much enhanced by the fact that the authors practise in the most distant parts of England, as Bedale, Southampton, Mansfield, &c.

It will be observed that all the writers agree in the main principles of laying out the buildings, and that it is much better to fatten stock in warm covered sheds, than in exposed draughty yards. Box feeding seems to be preferred to any other plan of housing stock.

Lord Portman and Mr. Thompson were the judges of the different essays; and Mr. Thompson, in a letter to Mr. Pusey, prefacing the different plans, has stated what the judges consider to be the main objects to be kept in view in making the decision; this is well worthy of perusal, as the merits of the plans are discussed in a most impartial manner; and the following are the conclusions they have arrived at, after a careful investigation of the subject:—

*1st.* That the communication between the different buildings of a farm should be by means of a paved or macadamized yard, and not across a straw fold.

*2nd.* That provision should be made for the introduction of loose boxes or stalls for fattening cattle.

*3rd.* That small open yards with covered sheds should be provided for young or store cattle.

*4th.* That covered manure pits are not generally advisable.

## STEADING FOR A 400-ACRE FARM.

Design for a steading adapted to a farm of 400 acres, 320 being arable, the remainder meadow. The stock is supposed to consist of a breeding flock of ewes, the produce of which are fatted off either as lambs or hogs; both bullocks and pigs are to be bought in.

This plan is the design of Mr. Haslam, a gentleman connected with the celebrated firm of Barrett, Exall, and Andrewes, agricultural engineers and implement manufacturers, of Reading. The leading principle proposed to be carried out in this design, is, that the passage of the straw shall be progressive, from its arrival at the barn till it reaches the manure depôt, never returning, or being unnecessarily carried about, which is too often the case. The stock, while fattening, are proposed to be kept under cover of one large roof, the building being open throughout, and consequently may be thoroughly well ventilated. The stables are conveniently placed in close proximity to the cart lodge, implement house, &c.; it is arranged for 16 horses, and divided in the centre: on each side of this division are funnels or shoots communicating with a loft above. By these funnels the corn and chaff are delivered to the carter, the quantity being regulated by a slide: this plan has the advantage of preventing the accumulation of any stale food remaining, as the last portion is always used first.

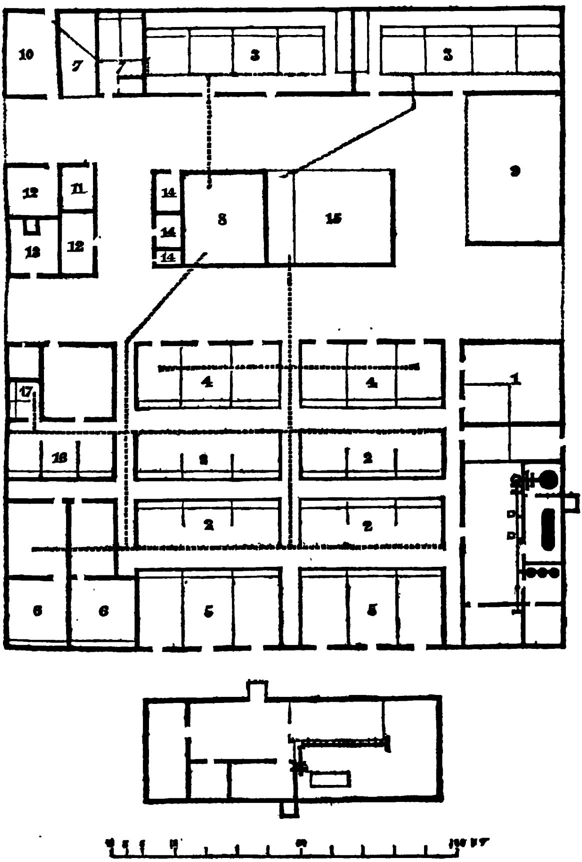
The sheep are housed on sparred floors of the same plan as Mr. Huxtable's. The hogs are similarly accommodated to the sheep, and the division between both hogs and sheep is formed of iron hurdles; this plan being considered the most economical, cleanly, and healthy, by allowing a greater circulation of pure air.

Open sheds, with small yards attached, are provided for young stock and sick cattle.

The corn from the rick is thrown directly into the ma-

chine for threshing and winnowing, and passes it for home consumption directly to the mill, thence to the food house, and from there to the stock; each time it is moved making a step in advance towards its ultimate destination, the manure pit, which is placed under the cart house, and is

PLATE II.



*C

the general receptacle for everything of such nature. The barn part and machinery are well arranged, the author having been assisted in this department by Mr. Bell, the intelligent foreman at Messrs. Barrett's factory. It consists of a six-horse-power steam engine, with machinery for threshing and cleaning the grain, a stone mill, crushing mill, oil-cake breaker, straw and hay chaff cutter, and complete apparatus for steaming the food.* This is in every respect a good plan, and well considered; but I would suggest, that neither cart nor implement sheds be placed over or near manure tanks, pits, or drains, as rapid rotting of wood, and corrosion of iron, must follow such a course.

object also to the plan of having the stock accommodated in one large building for the reasons mentioned in the description of the West-Peckham-farm steading.

*References to Plate.*

1. Barn and Granary.
2. Fatting sheds.
3. Cart-horse stables.
4. Hog sties.
5. Sheep pens.
6. Accommodation for young stock.
7. Gig house and nag stables.
8. Manure pit.
9. Implement shed.
10. Cottage.
11. Office.
12. Carpenter and smith's shop.
13. Poultry house.
14. Ash pit, privy, and tool house.
15. Cart shed.
16. Cow byre.
17. Calves pen.

## LORD TORRINGTON'S MODEL HOMESTEAD.

A few years back a considerable deal of notice was attracted to a farm steading, erected by Lord Torrington at West Peckham, in the county of Kent; and in a book written by his lordship, and published by Ridgway, in the year 1845, is a description of these farm buildings, with some useful general remarks on the agriculture of the county of Kent. Lord Torrington, like most persons who commence the construction of

* The cost of the machinery by this firm, complete to the steading, is about 310*l*.

model homesteads, started with a peculiar notion, upon the correctness of which would depend the success of the steading as an example to be imitated.

This new and leading feature his lordship describes as the "placing the whole farmyard under one roof adjoining the house; the lodges of various descriptions generally required being thereby dispensed with, and the farmer being enabled to see at all times whatever is going on, without the necessity of leaving his room." To effect this object he constructed, in the place of ordinary separate offices, one large shed, 90 feet long in the clear, by 54 feet wide; the height at wall plate 11 feet, and 26 feet to the top of roof; and in this building the cattle are lodged, and a variety of operations are to be carried on. It is calculated to contain 53 head of stock; namely, 32 bullocks, 8 heifers, &c., in addition to whose accommodation there are pens for 9 calves. Now this principle cannot be recommended for general adoption, as on very large farms it could not be carried out, and to construct such immense buildings is extremely injudicious and uneconomical; for as Lord Torrington himself thus observes, when describing this building, "It was a matter of considerable difficulty to know how to cover this *large* roof, *its weight being so great* and its *expanse so considerable*;" and for this reason it was an exceedingly injudicious proceeding to erect it, as it is most important in constructing farm buildings (which for reasons before mentioned, will not pay the interest of money on a large outlay), to have them as small in one dimension as possible; for it should be borne in mind in designing them, that to construct one building twice the width of another will much more than double the cost, as a tie beam for a roof 40 feet span is not only twice the length of one for 20 feet, but it must be much deeper and thicker, and the roof being much heavier, the point of support, the wall, must be much larger.

Otherwise than in the injudicious construction of this large stock lodge, the steading at West Peckham is an exceedingly

good one, and the details are extremely well arranged and designed. Any person interested in agricultural matters will find a considerable amount of valuable information in Lord Torrington's book.

## STEADING AT LISCARD, CHESHIRE

(ERECTED BY HAROLD LITTLEDALE, ESQ., FROM DESIGNS BY MR. TORR, OF RIBY, LINCOLNSHIRE).

This is one of the most recently erected farm steadings, it has been visited by most of the leading agriculturists of the present day, and is by all considered to be one of the very best example steadings in the kingdom. The late Sir Robert Peel honoured the property with a visit, and pronounced it to be the most complete he had ever seen.

Mr. Littledale's estate, upon which these buildings are erected, is situated in Liscard and the adjoining township of Wallasey, on the road from Liscard to Poulton cum Seacombe. It consists of an extensive range of farm buildings, including threshing barn, stables, piggeries, fatting and feeding sheds, labourers' cottages, and bailiff's house.

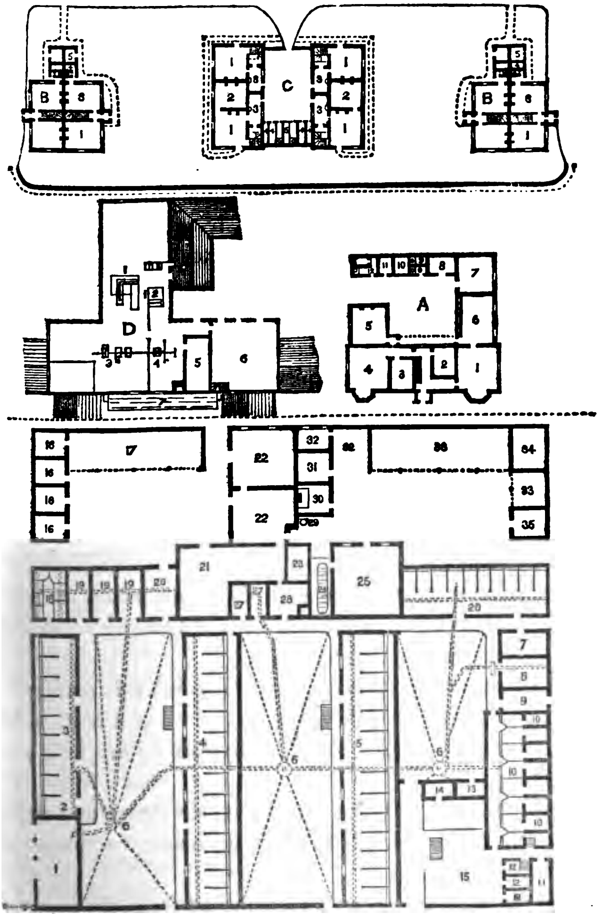
The form of plan adopted is an almost perfect square, surrounded on the north, east, and west with buildings, and on the south having a low wall. This form and arrangement give it an appearance of great compactness.

The square is intersected, east and west, by a range of buildings, consisting of stables, loose boxes, straw and threshing barns, and granaries; and north and south by two ranges of cow byres, and the principal barn. This arrangement of buildings divides it into five courts and yards, as shown in the annexed plate.

Almost in the centre of the steading is placed a substantial range of buildings, two stories in height (the rest are all of one story), which contains, on the ground floor, the straw barns, granary, engine house, boiling houses, cooking house, chaff house, &c.; and on the floor above is placed the threshing

machine and separator, chaff cutters, linseed crushers, and two pair of mill stones, which are placed in the granary on this floor. These machines are all driven by bands from the

PLATE III.*




* Farmer's Magazine, May, 1848.

motive power below. The winnowing machine is on the lower floor. Above the boiling house is a drying kiln, laid with perforated tiles, and heated with steam pipes. Adjoining this building is a raised tank for supplying the premises with water.

On the east side of this building is placed stabling for 10 horses, on the west side loose boxes, &c. The stables are fitted up in the most approved manner; the mangers are of iron, there are no racks, the whole of the fodder being cut into chaff.

*Cow Byres.*—The accommodation for fatting and breeding of oxen is in three lines of buildings, lying north and south, capable of containing in all 80 head of stock.

They are most excellently arranged in stalls, the divisions of which are formed by placing upright two large slates, secured to each other and to the mangers by iron rods, which keep them perfectly secure in their places.

The piggery is placed on the east side of the range, large and exceedingly comfortable. The feeding troughs are provided with a swinging leaf. Above the piggery is placed the accommodation for poultry.

The cattle courts are roomy and sheltered, and have liquid manure tanks in the centre.

The implement house and cart sheds are placed on the north side, and are spacious and convenient. Adjoining is the drill house, carpenter's shop, and smithy.

On the west side, at the north end, are placed root and potato stores, the floors of which are sunk below the level of the ground. The walls are filled with charcoal to act as a non-conductor.

Besides these offices there are a slaughter house and curing room, a churning house, a compost house, a place for grains, &c.

On the east side of the steading, detached from the principal

range, is placed the bailiff's residence, see Plan, Fig. A; and at the back of this is a range of offices enclosing a court-yard. Here is situated the dairy, which is a most excellent one (and will be found described under the head of Dairies), an apartment for salting and curing meat, and numerous other purposes.

On the south side are placed some well-arranged labourers' cottages.

The motive power is a most excellent steam engine of 10-horse power.

The threshing machine and separator are of the most approved form, and were made and fitted up by Parsons, of Clyburn.

The chaff cutters are by Mr. Corne. The whole of the machinery is of excellent workmanship and well fitted.

*Reference to Numbers on Plate* 3.

1. Compost house.
2. Bull house.
3. Shippon for 16 cows.
4. Ditto for 28 ditto.
5. Ditto for 32 ditto.
6. Manure tanks.
7. Gear house.
8. Milk-horse stable.
9. Pigs' food.
10. Piggeries.
11. Ducks.
12. Turkeys, geese, &c.
13. Shed for pigs.
14. Shed for poultry.
15. Poultry yard.
16. Potato stores.
17. Implement and root shed.
18. Calf house.
19. Loose boxes.
20. Grains.
21. Straw house.
22. Barn.
23. Engine house.
24. Boiler house.
25. Granary.
26. Stable for 10 horses.
27. Cut chaff.
28. Steaming house for roots.
29. Well.
30. Smithy.
31. Carpenter's shop.
32. Churn house.
33. Cart shed.
34. Drill house.
35. Slaughter house.
36. Stack yard.

*Reference* A.

1. Parlour.
2. Stores.
3. Office.
4. Living room.
5. Scullery.
6. Dairy.
7. Curing house.
8. Smoking house.
9. Privies.
10. Ashes.
11. Tubs, &c.
12. Oven and Boiler.

*Reference* B.

1. Living room.
2. Pantry and stairs.
3. Kitchen.
4. Ashes.
5. Coals.

*Reference* C.

1. Kitchen.
2. Parlour.
3. Scullery.
4. Coals.
5. Ashes.

*Upper Floor of Barn* D.

1. Threshing machine.
2. Separator.
3. Hay cutters.
4. Linseed crusher.
5. Drying kiln.
6. Granary.
7. Tank.

## MR. TIMM'S FARM, NEAR FRIMLEY, SURREY.

Amongst the many farms claiming to be considered as a model or example at the present time, I know of none to which more properly belongs the application of that term than does the little farm near Farnborough, belonging to Mr. Timm, for he sets the best of examples to his neighbours (and no one's neighbours need it more than his). I believe the native agriculturists of the district are much indebted to him for the introduction to their notice of many improved implements, as well as systems of husbandry; nor is it possible for the farmers of this district to be continually passing his well-ordered farm, with its small trim fences, clean land, and the grand ultimatum, heavy crops, without being struck with the fact that they have something to learn, and might, if they tried, do a great deal better than they do, if not quite so well as he does.

Mr. Timm's farm is situated about a mile from the Farnborough station on the South Western Railway, in the middle of the district geologically known as the Bagshot sand, perhaps the poorest description of soil in the kingdom, being purely a silicious sand, and not containing a single element besides, with which to supply nutriment to the plants growing upon it; the consequence is, that nine-tenths of the whole district is a barren heath, not affording a bite for the nearly starved animals that are occasionally to be met with upon it.

The lands of this district vary in quality more or less as they

approach and are mixed with the London clay, the underlying stratum upon which the formation rests; when much clay is mixed with sand, as it is about Hartford Bridge, the land is an easily worked, excellent loam, and lets for a high price.

Mr. Timm's farm is situated upon a middle description of the Bagshot sand, not nearly so good as the best, nor quite so bad as the worst, but a soil that would be, if in a state of nature, of a yellow, slightly loamy sand. Very much of this description of soil is out of cultivation, and that which is cultivated, with this exception, produces only the poorest crops.

Mr. Timm, then, is entitled to no small credit for growing regularly on such land a load of wheat to the acre, and that wheat 65 lbs. to the bushel, and all other crops similar in quality and quantity. There is no ostentatious display here, as in some model farms I could mention; everything is conducted on the most orderly and apparently ordinary manner, nothing is stinted and nothing wasted, and if farming can be made to pay at all, it will do so here.

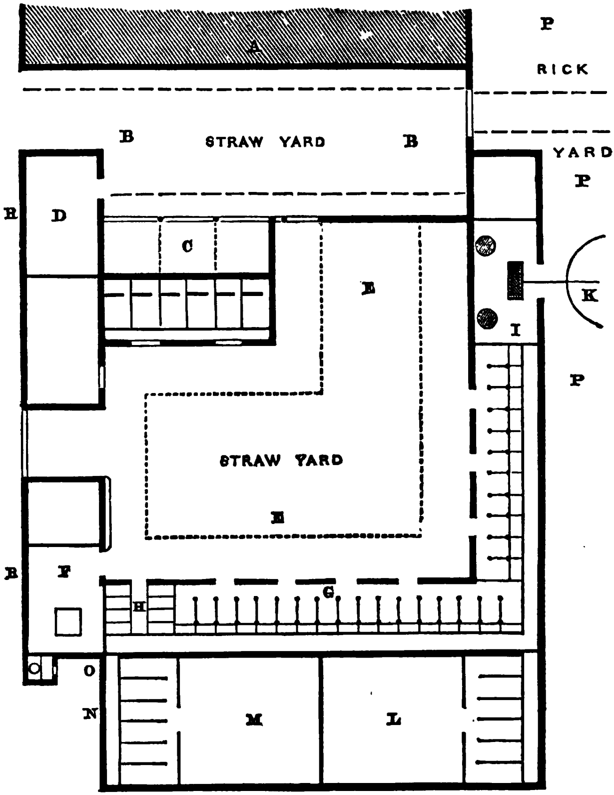
How is it now that this poor land is made to yield double, and in some cases treble, the amount of produce of those in the neighbourhood? Simply by farming higher (that is better), and employing as much capital as is necessary, and by keeping on this small farm (I think about 250 acres) 60 head of oxen, 350 sheep, 70 hogs, and 20 horses (12 of these at work).

The whole of the animals used upon this farm are of the choicest breeds, and are fatted to very heavy weights.

The consequence of this is, that an unusually large bulk of manure is annually made and applied to the land in the most judicious manner, that being the only way that such results are to be obtained.

The farm buildings, which is the point more immediately under our attention, have been constructed with great judgment, having a strict regard to economy.

Plate IV.—*Ground Plan of the Steading.*




A is the threshing barn, with straw and hay barn and granary adjoining.
B a straw yard.
C open stalls for stock.
D cart house and nag stables.
E straw yard, with paved causeway round it.
F the food cooking house, with steam boiler and steaming apparatus.
G a range of buildings divided into stalls for bullocks, with a gangway at the head for feeding the animals.

H calf pen.
I a building containing the chaff machine, bean mill, oat crusher, &c., worked from the horse gear at K.
L hammels and small yard for sick and other stock.
M hammels for two bulls.
N liquid-manure tank and pump.
O labourers' closet.
P stack yard.
R road.

The yards have a raised causeway round them to facilitate the business of the steading, and slope towards the centre, where drains are placed to carry the liquid manure to the tank; the buildings are all guttered, and every means taken to preserve the liquid manure from waste or dilution.

I think this ground plan, with some modifications, is well adapted to moderate-sized farms. The cattle sheds were constructed (with a view to economize materials) exceedingly low, and the result is, that in summer they are inconveniently hot. This may be easily obviated by covering the rafters with thin boards (5-cut stuff), and upon them placing a layer of felt and the slates upon it. The felt is very cheap (1*d.* per foot), and will have the effect of keeping out the cold of winter as well as the heat of summer. I have lately tried the plan by constructing the roof of a dwelling-house in this manner, and found great benefit in consequence. Mr. Timm's farm is the only one I know of where an attempt has been made to farm high upon the Bagshot sand; he has been singularly successful, and the agriculture of the district will, I am sure, be eventually raised higher from his example.

A most laudable attempt is being made in the same direction by another gentleman in this locality, upon some of the most worthless land in Great Britain, being the worst of the Bagshot sand before mentioned, but the liberal and vigorous system he is pursuing is likely to bring even it into heavy and good crops.

I must not conclude an account of Mr. Timm's farm with-

out remarking that he is fortunate in having for his bailiff so enthusiastic and intelligent a man in his art as Mr. Hutty.

## A SCOTCH STEADING.

Plate V. is the ground plan of an extensive Scotch steading,* considered by Mr. Stephen as a good example of its kind.

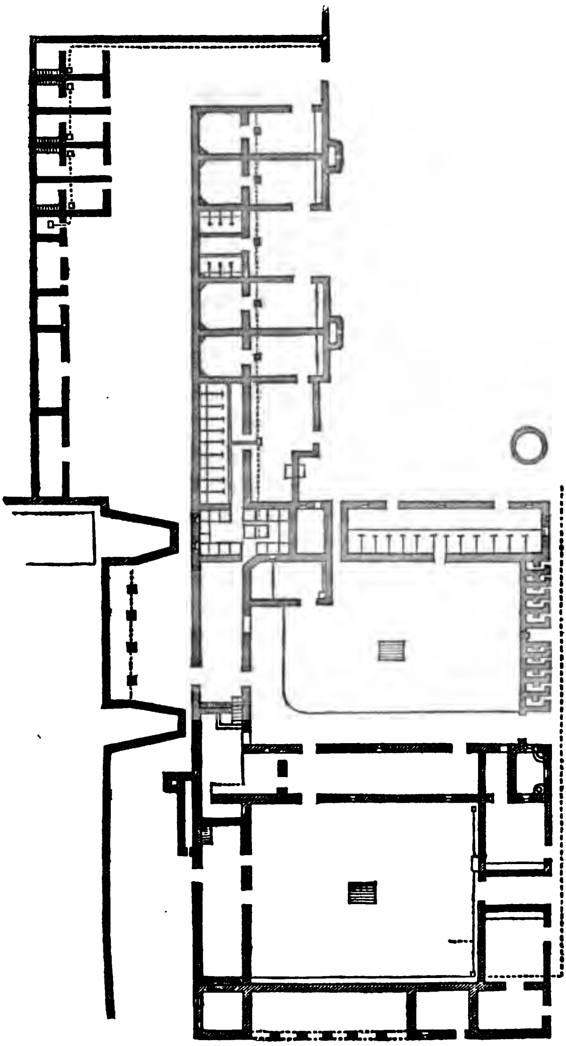
The agricultural character of Scotland stands much higher than that of England, for the Scotch have doubtless displayed more energy and ability in the management of their land than their southern neighbours; nearly all great improvements in agricultural machinery have originated with them. The threshing machine was invented, ploughs immensely improved, and the steam-engine first generally introdueed for agricultural purposes, north of the Tweed. It was not likely then that while other departments were advancing they would leave their homesteads unimproved; and consequently we see an extensive orderly well-regulated steading, with steam-engine attached, on every farm in the highly cultivated districts.

It is from the Sootch models that the English improved steadings have chiefly been copied, but the more recently erected are improvements upon them.

The principal difference between the Scotch plan of constructing farm steadings and the English is, that in the former the greater part of the stock are kept in hammels, which are small sheds with yards attached, containing one or several heads of stock; this necessarily causes a much larger quantity of walling, and consequently the eost of the steading is much increased. In England a system of continuous undivided sheds has been adopted instead, and no disadvantage has arisen in consequence that would at all justify the extra expense incurred in the former plan.

* See, for further elucidation, Mr. Stephen's valuable work, entitled the "Book of the Farm."

PLATE V.



## DESIGN FOR A LARGE STEADING.

PLATE I.—Isometrical view.

PLATE VI.—General plan.

PLATE VII.—Enlarged plan of threshing barn, engine house, cooking house, &c.

PLATE VIII.—Transverse section of threshing barn, straw barn, granary, &c.

This is a design for a homestead of the largest class, where all the operations are carried on in the most systematic manner, and is arranged according to the principles previously laid down.

The whole of the stock fattening for the butcher receive their food in stalls or boxes, while the young stock are accommodated in yards and hammels.

The whole of the stock receive food previously prepared, by cooking or otherwise; it is conveyed to them by means of a railway. This is rendered practicable by means of three turntables.*

The trucks running on this railway are arranged to take the food direct from the coppers, the roots from the stores, the chaff from the machine, and the meal from the granary or meal room, without any extra carriage; it being evident that, by adopting this plan, a great amount of manual labour may be saved, as well as loss or waste, from the food being dropped about in passing from one place to another. The food is all supplied at the animals' head, in a convenient manner, from the rail passage, which also offers great facility for the proprietor inspecting every head of stock by a few minutes' walk, without dirt, inconvenience, or danger. This facility for getting at the animals will be found of great advantage at night by the stock feeder, and prevent accidents.

* These are so constructed as not to cost more than 4*l.* 10*s.* each (see Second Part, on Agricultural Railways).

The straw barn is placed to receive the straw direct from the threshing machine; it may be made so large as to occupy the entire space shown in the plan (or even more), or it may be reduced to any dimensions, however small, without interfering with the advantages it possesses from its situation; that is, the being placed in the centre of all the stock, thereby offering the greatest facility for supplying all the boxes, stalls, hammels, yards, &c., with this bulky article.

The horses are placed in a position inaccessible to all other stock, in close proximity to the supply of chaff, corn, and straw.

The implement house, smithy, and shoeing place, are together, and also join the stable.

Everything belonging to it lies by itself, requiring neither the labourers connected with it to visit other parts of the farmery, or those connected with other departments to visit it; thereby preventing all idle gossiping and waste of time amongst the persons employed, or the interference of any one person's duty with that of another.

The granary is placed above the threshing barn and part of the straw barn. It is intended to receive the whole of the corn immediately after threshing, so that there be neither waste nor robbery.

The building containing the granary is proposed to be constructed in a much more substantial manner than any of the other offices; and for this purpose, it is so arranged that all the most valuable portion of the property of the tenant shall be contained in it. (By the adoption of this plan the cost of the other buildings may be lowered.)

The lower floor contains the winnowing and other apparatus for cleaning the corn, and tackle for raising the various articles to the mills above.

The floor of this building is proposed to be sunk three feet below the level of the ground outside, to enable the rick-yard

waggon to deliver the sheaves on a level with the threshing barn, and render the use of elevators unnecessary.

The middle or stage floor is constructed in a substantial manner, strongly framed with timber, and upon it are placed the threshing machine and straw shaker, the barley hummeller, the smut machine, the bruising mill, oil-cake crusher, steel mill, and a pair of meal stones, dressing machine, &c. The threshing machine occupies the centre of the stage, and the smaller machines are placed against the walls, so as to be out of the way of the operation of thrashing.

On the upper floor of this building is the granary, fitted with hoppers to supply the corn to the machines below. A sack tackle is constructed in the roof of this apartment, and there are sack traps to each floor for the convenience of hoisting the sacks.

By the side of this building is placed the steam engine.

The boiling house adjoining is a small detached building.

The fuel house nearly adjoins the boiler house.

The cooking house is next the engine-boiler house, from whence the steam is supplied for cooking the various roots, steaming chaff, &c.

The meal store, cooking house, chaff house, root-washing house, and root stores, are close together, and from them the railway communication is perfect to *every animal in the building;* the chaff and corn are delivered at one end of the stable into a small apartment partitioned off for the purpose.

The meal house is so situated as to be supplied by shoots direct from the granary.

The straw is brought from the ricks to the threshing barn by a peculiar truck* which I have invented for the purpose, and is designed to run on lines of rails at right angles to each other; this is to obviate the necessity of using turntables,

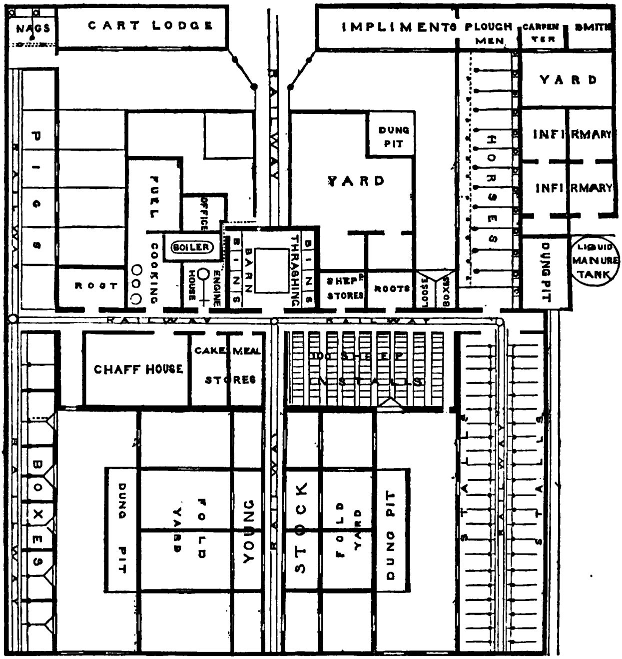
* For description and plan of this truck, see Part II.

several of which would be necessary, as the lines of ricks are arranged at right angles to each other, so that any particular rick may be got at that may be required to be immediately used.

The manure is cast out from the various courts, boxes, stables, &c., into pits conveniently placed for the purpose, from whence it is carted to the middens, or to the land; from beneath these pits are pipes to carry the liquid manure to a common receptacle, from whence it is pumped by the engine into a tank placed at a high level on the farm, or into an elevated iron tank, so that it may descend by its own gravity to the land when required. I consider that a great saving will arise by thus throwing upon the engine the whole labour of pumping up the liquid manure, in lieu of its being pumped from the tank by the carters, and carried to high levels in carts drawn by horses. Should this plan not be adopted, that is to say, of placing the tank at some distant spot, I would recommend that it be raised sufficiently high to fill the carts, (instead of being a sunk well,) and be filled by the engine instead of hand labour.

## Plate VI.

### *Ground Plan.*




**Scale, 30 feet to an inch.**

An isometrical view of this steading faces the title page of the book. It is proposed to construct the straw barn of open sparred work; the thrashing barn and granaries as in the annexed plates, and the bullock sheds as at Plate XI., only a double row of beasts are on each side of the railway.

PLATE VII.—*Enlarged Plan of Threshing Barn.*

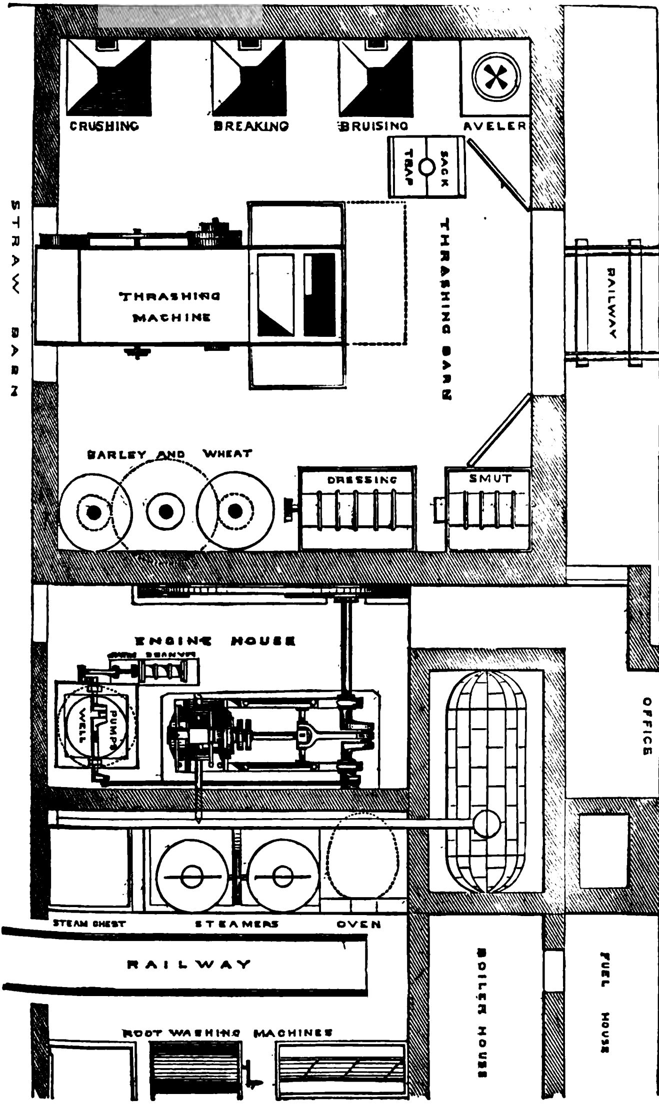
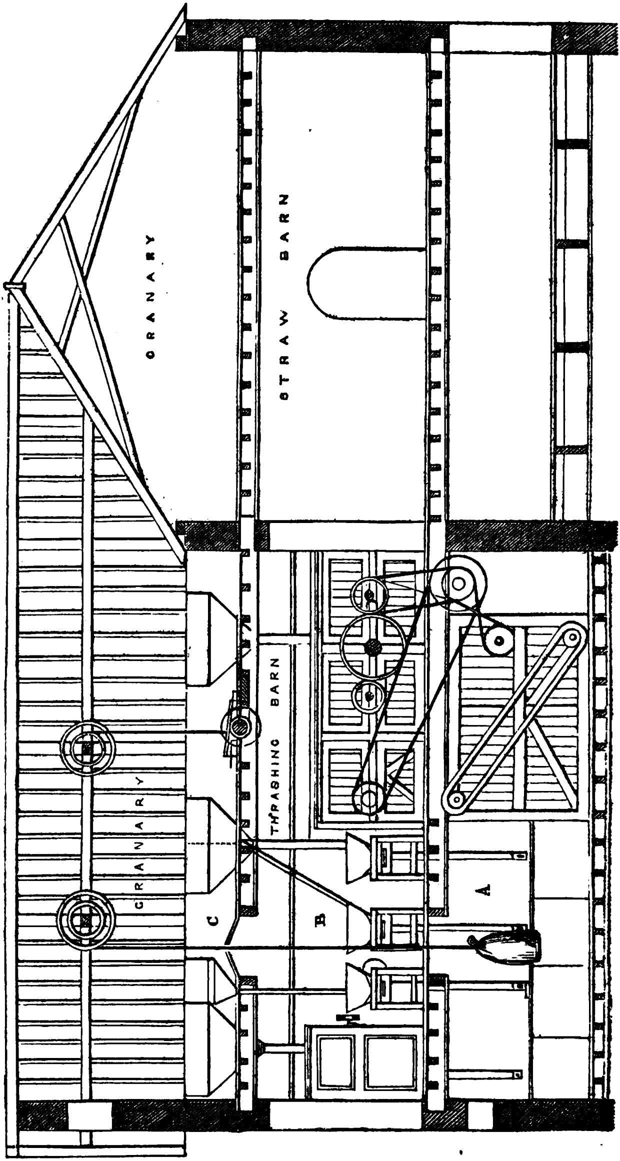


PLATE VIII.—*Section of Threshing Barn.*



# CHAPTER II.

## ACCOMMODATION FOR STOCK.

The breeding, rearing, and fattening of stock are a most important division of the business of a farmer, demanding his utmost care, skill, and attention. Badly bred, fed, or housed stock are not consistent with good farming, and can never be made to pay. It has been before observed, that high farming is economy of labour and manure, and plenty of both. Now the economy of labour and manure, in reference to stock, will depend principally upon the judicious arrangement of the sheds, hammels, courts, &c., for the better supply of food, removal of the dung, and preservation of the liquid manure.

In the old steadings no arrangements exist for securing any of these advantages, and the accommodation is of the poorest description,—small, ill-contrived, and quite unfit for the most approved present systems of managing stock.

The size and arrangements of buildings for stock will, of course, depend a great deal upon the description of steading, whether for dairy, stock, or sheep farm; but this little book being only an elementary treatise, we shall confine ourselves more particularly to mixed husbandry, of which description by far the larger number of English holdings are.

The buildings and other accommodation necessary for the mixed-husbandry farm, to accommodate the stock, consist of

- Stables for working horses.
- Fattening sheds for bullocks.
- Byres for cows.
- Sheds and pens for calves.
- Piggeries.
- Sheep sheds.
- Hammels for young stock and bulls.
- Infirmary for sick cattle.
- Yards for folding stock at night and in inclement weather.
- Small buildings for poultry, &c.

## STABLES.

*The Cart-Horse Stable.*—I have heard it asserted by good authorities in agricultural matters, that they could tell the state of everything else on the farm, if allowed to inspect the cart-horse stables; and I have no doubt of the fact, for I know of nothing so indicative of good farming as a well-ordered stable.

The accommodation for working horses is in most old steadings of the most wretched description—low, dark, filthily dirty, and very unwholesome (from want of proper ventilation), and in consequence, farmers' horses are generally found in an unhealthy state (though want of food has something to do with this—bad farmers being proverbially bad masters to their horses).

In constructing farm-horse stables, it is of the first importance to give them room enough (12 ft. in height and 16 in width are the minimum dimensions).

This 16 ft. width should be appropriated in the following manner:—2 ft. for the manger, 7 ft. for length of stall, 1 ft. for the drain, 4 ft. for a clear gangway behind the horses, to facilitate the removal of manure, and the other business of the stable, and 2 ft. for the projection of the harness, &c., hanging on the tacks behind each horse.

Separate stalls should be provided for each animal by a partition called a travis. (On no account should a swinging bar be used, bad accidents often occurring from this ill-advised economy.) The travis should be five feet high at the tail post, and rise to seven feet at the head, as shown in Plate IX.

The posts for supporting it should be of oak or cast-iron, securely fixed into the ground, and, if the construction of the stable admits of it, also to the joists of the floor overhead.

The top of the travis, called the ramp rail, should also be made of oak, tenoned into the tail post at one end, and the

bond timber of the wall at the other. On the under side is a groove in which the upper end of the stall boarding is placed, the lower ends being secured in the same manner, with a corresponding piece of timber, or, what is better, stone, which is grooved in the same manner as the ramp rail.

The divisions of stalls are made in a variety of ways, according to the description and cost of the stables. The directions here given apply to farm-work-horse stables, where no unnecessary outlay is expected to take place.

The rack and manger are variously placed; the usual plan is a wooden or stone trough, extending the whole length of the stable, and the rack in the same manner above—the hay being dropped from the loft overhead into it; but this plan is liable to a variety of objections. The rack being placed overhead, the horse will draw and let fall among the litter (and therefore waste) as much as he eats. Blindness in horses also is frequently caused by hay-seeds falling into their eyes when eating from high racks; nor can the defence of its producing high carriage apply in the case of work horses, as they are not required to hold up their heads, like carriage and other horses; and generally, on returning to the stable, are so tired, that it is unnecessary cruelty to force them to feed in that way. The most approved plan is to place the rack low down in one angle, and the manger in the other, which allows of the horse eating while lying down. The manger is often made the whole width of the stall, sloping inwards towards the ground, to be out of the way of the horse's fore-legs.

In the woodcuts I have not shown any rack, nor should ever think of using one myself; but I know some horse-keepers are made quite unhappy by the sight of a stable without racks, as I have frequently found them putting a pile of hay upon the litter in one corner of a stable, although the horses never eat a mouthful of it. The plan now generally adopted, and found to answer, is to give the horse nothing but

chaff, and very often the oats bruised and mixed with it. I have myself tested the merits of this plan, and shall always in future adopt it. When food thus prepared is placed in the long manger, it is necessary to put small bars across, in two or three places, to prevent the horse routing the food over the edge with his nose.

The floor of the stable is paved in various ways, changing with the materials found in different localities. For a description of these see article on Floors for Agricultural Buildings.

*Drainage.*—The paving of the stalls should slope from each side slightly towards the centre, and from the head to the hind post, not more than about one inch in four feet. If more than this the horse will not stand comfortably, as there will be a continued strain on the tendons of the hind legs. It has been observed, that a horse will always choose a level piece of ground to stand on when he is free in a grass field, and much more ought he to have it in a stable, which is his place of rest.

Transversely to, and behind the stalls, there should be an open way or drain running the whole length of the stable, as close as convenient to the hind posts. Between each pair of stall posts, in the line of this drain, should be an iron grating, not less than a foot square in the clear, with a cesspool below, as shown in Plate IX. and not less than two feet deep, and lined with cement, from this the liquid-manure drains should be laid.

*Ventilation.*—This is one of the most important points to be attended to in the construction of the lodgings of all cattle, but with no animal is it so important as with the horse.

The doors and windows are usually the only apertures through which the exhalations from the stable can find a way out; and in the winter time, when these are necessarily closed

to keep the animals warm, the stable is found to be in a most unhealthy state. I cannot do better than quote Mr. Stephens's description of the general state of farmers' stables. He says,—" It is distressing to the feelings to inhale the air in some farm stables at night, particularly in old steadings economically fitted up. It is not only warm from confinement, moist from the evaporation of perspiration, and stifling from sudorific odours, but cutting to the breath, and pungent to the eyes, from the decomposition of dung and urine by the heat. The windows are seldom opened; and many can scarcely be opened by disuse. The roof, in fact, is suspended like an extinguisher over the half-stifled horses. But the evil is still further aggravated by a hayloft, the floor of which is extended over and within a foot or less of the horses' heads. Besides the horses being thus inconvenienced by the hayloft, the hay in it, through this nightly wasting and fumigation, soon becomes brittle, and contracts a disagreeable odour." This is not an exaggerated statement, as I have found work-horse stables in most old steadings to be in quite as bad a state as he describes.

The great point to be attained in ventilating these buildings is to give an ample supply of fresh air without causing a positive draught; and this is best done by building into the wall, close to the ceiling joists, iron air-bricks. Of these bricks—if the same size as an ordinary sized brick, *i. e.* $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$ inches—one should be allowed for each horse; and for every eight horses there should be a proper ventilator through the roof of not less dimensions than would contain 36 cubic feet of air. The sides of the ventilator should be fitted with louvre boards, set at a very acute angle to the jamb. This will effectually keep out all violent draughts, and prevent rain and snow from beating in. At the bottom of the ventilator should be placed a wire-gauze flap, as described in the article on Ventilation, and attached to it a cord and pulley, by which the opening may be adjusted

PLATE IX.—*Cart-Horse Stables.*
*Transverse Section and Plan.*

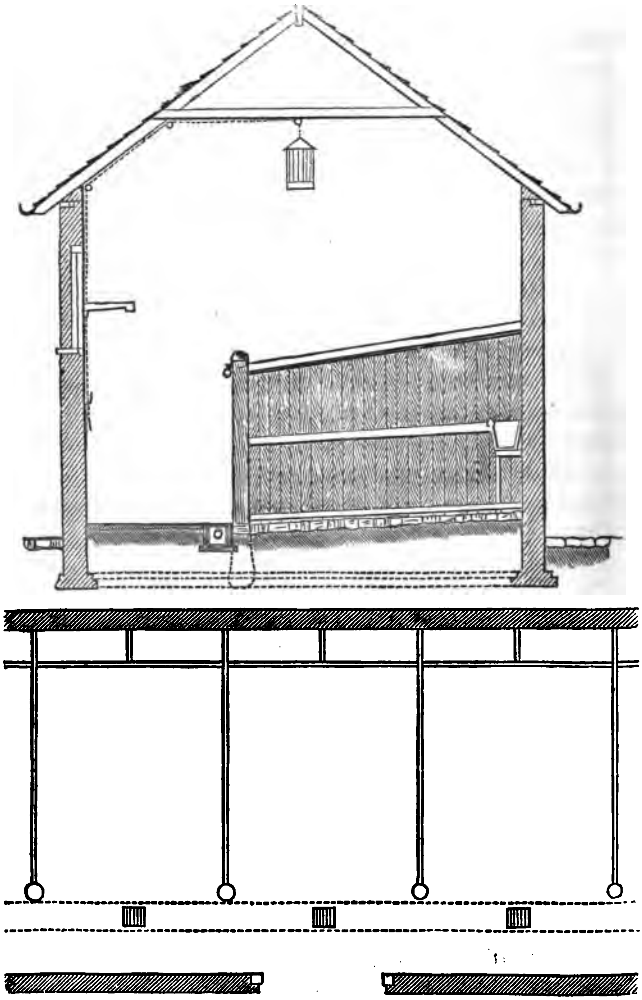


PLATE X.—*Cart-Horse Stables.*

*Longitudinal Section.*

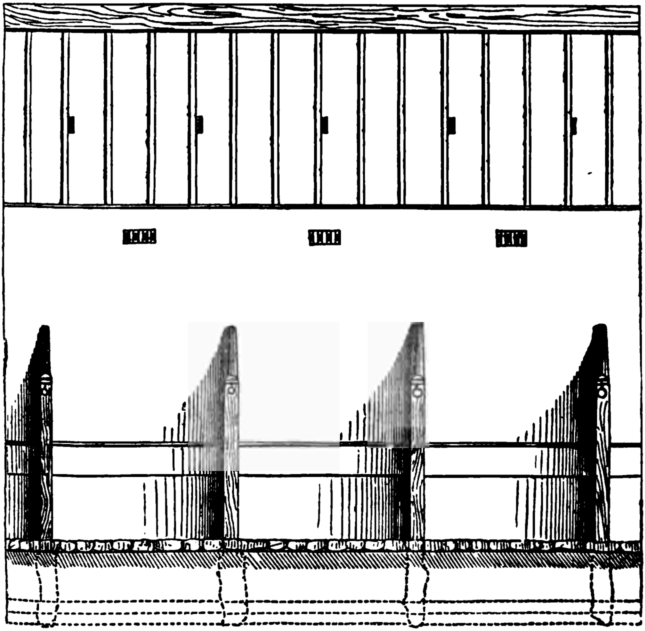


*Fig. 2.—Stable Window.*

according to the state of the weather. When these ventilators are used there need be no louvre boards in the windows, but if not, the window should then be divided into three compartments by mullions, the two side divisions being fitted with glass, and the centre one with louvre boards with adjusting rack, or as in *Fig.* 2.

In a large stable I myself erected, this ventilation was found to answer tolerably well, the fresh air being admitted by the louvre boards in the windows, and the foul air emitted through the air bricks, two bricks being allowed for each horse; but I should decidedly recommend that ventilating hoppers be always fitted in the roof, and the fresh air supplied through openings in the lower part of the walls, the apertures covered with perforated zinc. By these means an equal temperature, with perfect ventilation, may be preserved both winter and summer.

Cart-horse stable doors should be made in two halves, an upper and lower. A thumb-latch, and a good lock and key should be provided. The manner of storing and supplying the food to horses is rather an important point. In stables generally there is a large bin or chest in which the corn is kept, but in constructing new buildings for this purpose, it is much better to arrange for a small separate apartment for mixing and preparing the food. This is the more necessary when the practice is to mix the corn with chaff.

This should be done by the bailiff or foreman, and the allowance delivered out to each ploughman or carter for his particular team of horses, thus putting an end to some of the malpractices so well known to exist by all persons who have much employed this class of men and horses.

In this room, called the horsekeeper's room, should be kept, in a closet, any small necessaries occasionally required in the stable, and amongst these the requisite medicines, balls, &c., to be ready in case of horses being taken suddenly ill.

Plates IX. and X. are the plan and sections of a cart-horse

stable, constructed in an economical and substantial manner, and the following are the quantities and estimates for constructing the same :—

| | | £ | s. | d. |
|---|---|---|---|---|
| 20 yards cube excavation | at 3*d.* | 0 | 5 | 0 |
| 3¾ rods of reduced brickwork | at 8*l.* 10*s.* | 31 | 17 | 6 |
| 40 in. run of brick, on edge, in cement | at 4*d.* | 0 | 13 | 4 |
| 40 in. run of cement filleting | at 2*d.* | 0 | 6 | 8 |
| 10½ square of slating | at 20*s.* | 10 | 10 | 0 |
| 48 in. run of ridge to ditto | at 6*d.* | 1 | 4 | 0 |
| 672 in. superficial of paving to stable, &c. | at 1*s.* | 33 | 12 | 0 |
| 7 inch cube of stone sills to doors | at 2*s.* | 0 | 14 | 0 |
| 90 ft. superficial of inch-ledged doors | at 4*d.* | 1 | 10 | 0 |
| 407 ft. superficial 1¼-matched and beaded boarding to stalls | at 5*d.* | 8 | 9 | 7 |
| 19 ft. 6 in. cube wrought oak posts, &c. | at 4*s.* 6*d.* | 4 | 7 | 9 |
| 84 ft. cube fir joists, rafters, &c. | at 1*s.* 6*d.* | 6 | 6 | 0 |
| 30 ft. cube wrought fir door and window frames | at 1*s.* 7*d.* | 2 | 7 | 6 |
| 22 ft. 6 in. superficial louvre boarding to windows to open and shut | at 7*d.* | 0 | 13 | 0 |
| 11 ft. 6 in. superficial glazed sashes | at 1*s.* 9*d.* | 0 | 19 | 11½ |
| 20 ft. run ¾-rounded fillet | at 1½*d.* | 0 | 2 | 6 |
| 10½ square of slate boarding | at 7*s.* 6*d.* | 3 | 18 | 9 |
| 60 yards superficial of painting, in 3 oils | at 6*d.* | 1 | 10 | 0 |
| No. 2 heads, at 6*d.*, and 2 shoes, at 6*d.* | | 0 | 2 | 0 |
| 130 yards superficial twice lime white | at 1*d.* | 0 | 10 | 10 |
| 96 yards run 3-in. guttering zinc | at 3*d.* | 1 | 4 | 0 |
| 18 yards run 2-in. rain-water pipe do. | at 4*d.* | 0 | 6 | 0 |
| No. 2 heads, at 1*s.* 10*d.*, and 2 shoes, at 1*s.* | | 0 | 4 | 8 |
| 40 brackets and nails to ditto | at 4*d.* | 0 | 13 | 4 |
| Manger complete and fixed | 1*s.* 6*d.* per foot run | 3 | 12 | 0 |
| 3 10-inch stock locks, at 1*s.* 9*d.*, 3 stable latches, at 1*s.*, 16 manger rings, at 4*d.*, 8 stable grates, at 10*d.* | | 3 | 19 | 9 |
| 2 ventilators in roof, with moveable louvre boarding, painted and fixed complete | | 4 | 0 | 0 |
| | | £90 | 7 | 3½ |

The above shows a cost of £11 6*s.* per horse.

All the interior fittings of the stable are manufactured separately of iron and other materials, but they are chiefly adapted for hunting, carriage horses, or nags' stables; the cost rendering them inappropriate to the lodging of cart horses.

The paving of stables is done in a variety of ways, depending chiefly upon the local materials, such as faced flints, blocks of the harder description of chalk, or a chalk puddle primed in. Moore stone is used in the southern counties of England, and is one of the best materials I know for the purpose. Clay and smiths' ashes make a very good bullock-shed floor, but it does not last under heavy horses. Wood blocks are good, but absorb urine to too great an extent. Kamptulicon has been proved in cavalry stables to be the most perfect floor. I have just paved my own stable with slate cuttings set edgeway, with cement—it is both good and durable. Behind the horses, from the drains to the walls, I prefer a pavement of hard bricks; the liquid-manure drains should be glazed earthen pipes, or what is known as Vauxhall stone ware.

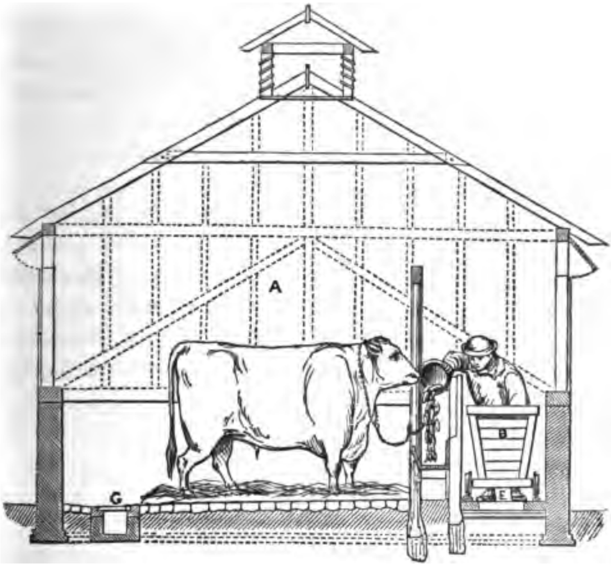
## BOXES AND STALLS.

*The Bullock-fattening Shed.*—Throughout Switzerland and Flanders the practice has long existed of keeping the cattle constantly in the house, where they are fed upon cut grass, clover, and other green food. This is a most excellent mode of procuring rich manure, and the plan is as profitable to the feeder as it is good for the stock.

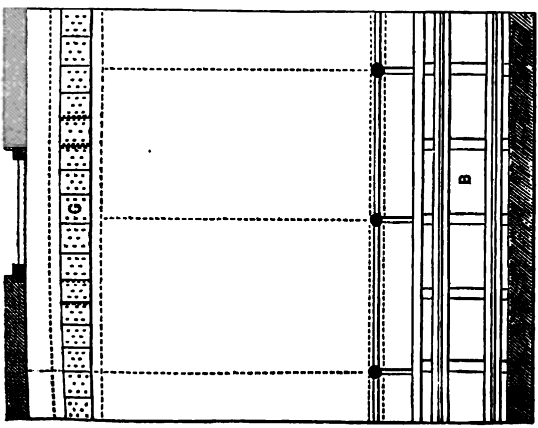
The practice of stall feeding or soiling has been gaining ground for many years, owing chiefly to the successful results of the system as proved by the late Earl Spencer, the Duke of Richmond, and other noblemen, who have carried out experiments on a great scale, to test the merits of the plan, and no homestead can be considered perfect that has not proper and scientific arrangement made for the soiling of stock; the general opinion being now decidedly in favour of fattening all stock in covered, comfortable sheds, in pre-

PLATE XI.—*Bullock-fattening Shed.*

*Transverse Section.*




*Plan.*



ference to their remaining in the open air. Young animals, requiring exercise, will generally grow better, and more vigorously, in the open pasture, than when confined to sheds or courts, but this is not the case with animals fattening, as warmth and rest are the most conducive to that operation, and these can only be obtained by stall feeding. It is now proved beyond a doubt, that a bullock gets fat much sooner, and consumes much less food in doing so, in a shed or stall, than in the open field.

In their anxiety to carry out this system in the best and most efficient manner, many of the noblemen and gentlemen who have adopted it have laid out extravagantly large sums in the erection of their bullock sheds, or stalls, such as no farmer could afford to pay interest for. Indeed, I have myself observed on some estates, that a larger sum has been

*Fig. 3.*

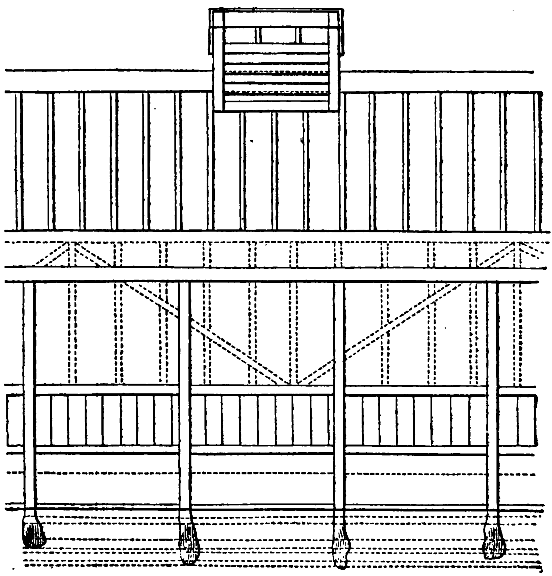
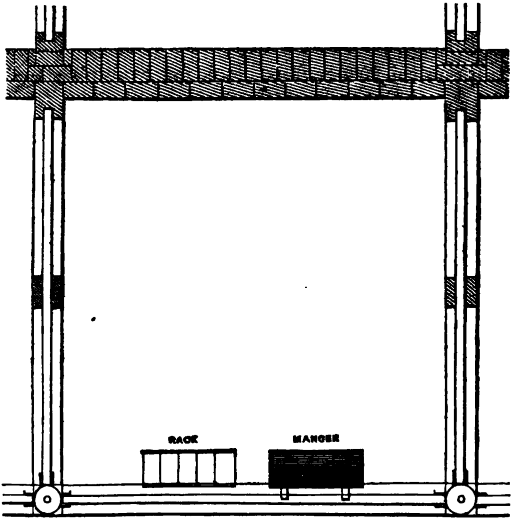
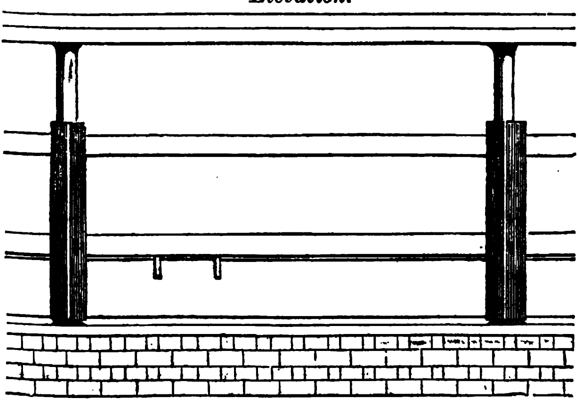


PLATE XII.—*Design for a Loose Box.**

*Plan.*




*Elevation.*



* This design for a loose box is copied from one by J. Ewart, Esq., in the Journal of the Royal Agricultural Society for 1850.

expended for the accommodation of a single bullock than for that of a whole family of labourérs.

Warm, dry, and well ventilated cattle sheds have been constructed in many places at a very small cost, and it is to these that the practical farmer must look for example; the following being the chief points to be attended to:—

1st. That the lodging of the animals be dry, warm, and well ventilated, with arrangements for maintaining as nearly as possible an equal temperature.

2nd. That the arrangements for supplying the animals with litter and food be such as will most economize the labour of the cattleman, and there should be equal facility for removing the manure from the sheds and stalls.

3rd. That cesspools and liquid-manure drains be so arranged that not a drop is wasted.

4th. That all this be done at the smallest possible cost.

*Fig.* 4.—*Section.*

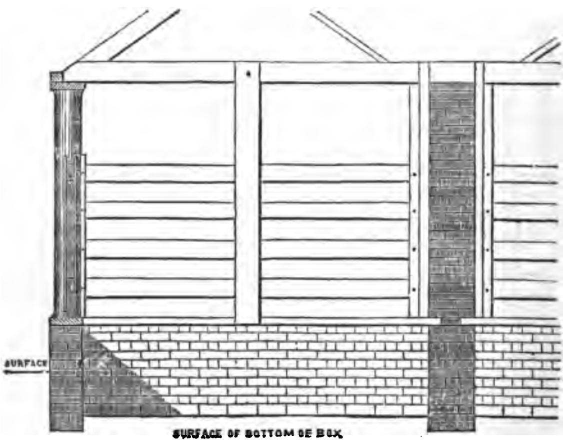


Plate XI. is a plan and section showing the accommodation for one animal, and *Fig.* 3 is a longitudinal section of the same, which may be continued to any length.

A, is the lodging of the animal, which should be arranged for each bullock to have to itself 5 feet of width. This should be paved with some hard material, the nature of which will generally depend upon locality. (For description of material for flooring cattle-feeding sheds, see the article on Floors.)

Each animal will be secured in his position by a chain or strap round the neck. This is fastened to a ring which slides freely upon the circular post C, the lower end of which is let into the floor, and the upper end securely fixed to the joists of the floor above. Should there be no loft over, a strong rail must be run the whole length of the shed, and be occasionally secured to the wall by a transverse tie; into this the heads of the stall posts must be securely tenoned.

B, is a space railed off, 4 feet wide, for the purpose of enclosing a single line of rails, upon which a truck runs for supplying the animals with food of various kinds.

In the ground plan of the example steading, Plate VI., it will be observed that this line of rails runs right up to the coppers to receive the cooked food, as well as to the chaff-house and the different root stores, the turnip cutter, and gorse bruiser. This should always be done, and if possible a straight line should be preserved, as the cost and inconvenience of turn-tables is considerable.

E, is the line of rails for the truck, and is here shown as cast upon the top of an iron pipe. These pipes are for the purpose of containing hot water or steam to warm the building in exceedingly cold weather.

I have thought it necessary to make these provisions in consequence of the principle being now thoroughly established, (a fact that farmers cannot be too often reminded of,) that warmth is equivalent to food, and that if they allow their fat

stock to suffer from cold, they are throwing away a proportionate quantity of food.

Between the stall posts and the rail are placed the feeding troughs. There should be two of these to each animal—one to contain the food, the other the water.

At the back of the trough, behind the railing, should be placed a pipe for supplying water to the trough, with a separate tap to each animal.

The plan is often adopted of keeping the water in all the troughs at a uniform level, by means of a cistern and ball cock at one end. The taps are the only saving, and as it is exceedingly inconvenient, it is a plan that cannot be recommended.

Behind the animal, running lengthways of the building the whole length, is the liquid-manure drain, G. This is 15 in. wide and 18 in. deep, built of brick and lined with cement, the top is covered with small boards, placed transversely across and bored with holes.

I consider this mode of constructing the drain to be the best, as it can be made of any materials, be easily cleared out, and affords ample opportunity for the liquid to flow through to the drain when there is a large quantity of dung on the floor.

The front of the shed next the yard is shown as constructed of brick to 4 feet from the ground; above that it may be weather boarded. It is sometimes constructed of spars, 3 inches wide, placed 3 inches apart, but by this plan I have always found the sheds very cold in the winter. Weather boarding is best up to within a foot of the top, where it may be open sparred work with a board hung on hinges, to be open or shut at pleasure, according to the temperature, as shown in Plate XI.

This plan is designed under the supposition that the stalls will be cleaned every day or two. If it is intended to allow the dung to accumulate under the animal, and the clean litter to be always put on the old, there will then be required dif-

ferent arrangements for the feeding, as the troughs must be made to shift up as the manure increases in thickness. There was an arrangement of this sort at Mr. Mechi's, ingeniously done, but I should decidedly not recommend the plan of allowing any great accumulation of dung in sheds of this description, it is much better to have sunk stalls, or boxes.

This is a very favourite plan with many persons; it has however one great objection, that is, the cost of constructing the boxes, and I have not seen any corresponding advantages. If two animals are put into one box and tied up, as is often done, they might just as well be in an ordinary shed; as the principal advantage said to be derived from box feeding is to use it as a loose box, and allow the animal to turn about and lie down just which way he pleases. I have, however, seen animals of the largest kind fatted, without any discoverable inconvenience, side by side in large sheds.

*Quantities and Estimate for Eight-Stall Bullock Shed.*

| | | £ | s. | d. |
|---|---|---|---|---|
| 10 yards cube of excavation to foundations . | at 3*d.* | 0 | 2 | 6 |
| 1⅗ rods superficial of reduced brickwork . | at 8*l.* 10*s.* | 13 | 13 | 4 |
| 64 yards superficial of paving to stalls . . | at 1*s.* | 3 | 4 | 0 |
| 9½ square superficial of Countess slating . | at 20*s.* | 9 | 10 | 6 |
| 42 feet run of ridge to ditto . . . | at 6*d.* | 1 | 1 | 0 |
| 32 yards superficial of twice lime white . | at 1*d.* | 0 | 2 | 8 |
| 38 feet cube of oak sawn die square . . | at 4*s.* 9*d.* | 9 | 0 | 6 |
| 31 feet cube of oak wrought all round . | at 5*s.* 6*d.* | 8 | 10 | 6 |
| 40 feet superficial of inch oak . . . | at 10*d.* | 1 | 13 | 4 |
| 122 ft. 4 in. cube of fir, rafters, plates, &c. . | at 1*s.* 6*d.* | 9 | 3 | 6 |
| 11 feet cube of fir, wrought . . | at 1*s.* 9*d.* | 0 | 19 | 3 |
| 9½ square superficial of slate boarding . | at 7*s.* 6*d.* | 3 | 11 | 3 |
| 2½ square superficial of ¾ weather boarding . | at 16*s.* | 2 | 0 | 0 |
| 212 ft. 6 in. superficial of 1¼-inch wrought boarding | at 8*d.* | 7 | 1 | 8 |
| 80 feet superficial of inch flap hung . . | at 6*d.* | 2 | 0 | 0 |
| 60 feet superficial of inch ledged door . | at 9*d.* | 2 | 5 | 0 |
| | Carry forward | 73 | 19 | 0 |

| | | £ | s. | d. |
|---|---|---|---|---|
| | Brought forward | 73 | 19 | 0 |
| No. 12 pair of hooks and bands, at 1s. 6d., 2 Norfolk thumb latches, at 7d., 2 9-inch barrel bolts, at 9d. . . | | 1 | 0 | 8 |
| 84 feet run of 3-inch cast-iron eaves guttering . | at 4d. | 1 | 8 | 0 |
| 32 feet run of 2-inch cast-iron rain-water pipe . | at 5d. | 0 | 13 | 4 |
| No. 2 heads, at 1s. 10d., 2 shoes, at 1s. . . . . | | 0 | 4 | 8 |
| 14 yards run of railway . . . | at 4s. 6d. | 3 | 3 | 0 |
| 30 yards superficial of painting in 3 oils . | at 6d. | 0 | 15 | 0 |
| | | £83 | 2 | 8 |

The above shows the cost to be £10 7s. 10d. per bullock.

Plate XII. is a plan and section of a loose box, 9 feet square. This is the size considered the best by authorities upon the point, and I think it would be a false economy to make them less. The floor of the box is sunk 18 inches below the door sill, and is well paved. As has been before observed, the animal stands in this box upon the manure, which is not removed, but fresh litter continually added, and doubtless the manure from being so thoroughly compressed is subject to little loss, and will be in an excellent state when taken out; but I cannot agree with some authorities, that this plan is the most economical method of making beef.

That animals can be fatted more economically in well sheltered, comfortable, and dry buildings than in wet, cold yards cannot be questioned, and we may with advantage quote the excellent remarks of Mr. Ewart upon this subject, in his Essay on Farm Buildings, in the Journal of the Royal Agricultural Society for 1850.

"The generally imperfect management of fattening stock, and the negligent preparation of manure so prevalent in times past, cannot enable the husbandman of Britain to meet, without diminution of capital, the unrestricted competition of foreigners in the British market in every kind of produce of the soil which he will henceforth have to encounter. The

excrements of a few half-fed wintering cattle, and the litter of an open yard exposed to the alternate effects of rain, wind, and sunshine, will do little in raising such grain crops as to enable the British farmer to maintain, much less to promote, a profitable employment of his capital, and of native industry in the cultivation of the soil. Nor will the estate of the landed proprietor be supported in its present value in the absence of accommodation for the fattening of cattle with the greatest economy and convenience for preparing manure without waste of its fertilizing properties.

"The essential conditions on which the fattening of cattle can be obtained with the greatest economy, are warmth, quietude, wholesomeness of atmosphere, and cleanliness. And of all accommodations that have probably ever been invented for the feeding of oxen, none has so completely answered the principal object of converting the vegetable productions of the earth into food for mankind in the shape of flesh, as the plan of feeding in boxes or loose stalls, first suggested by Mr. John Warnes, of Trimingham in Norfolk; nor does any plan more completely fulfil a secondary but scarcely less important object, the raising manure of the best quality with the greatest economy, than the accommodation alluded to. There cannot exist, in the mind of any individual who may have witnessed the feeding of cattle in boxes properly carried out, a doubt of its being a most effectual mode of providing due shelter, perfect freedom from molestation, and complete comfort to the animals—all conditions most essential to rapid thriving; nor can any one behold the accommodation without being thoroughly convinced of the great economy in collecting the egesta and preserving it in the very best state for its purposes, and yet without the least exhalation of effluvia. Whatever may be supposed, those who have not seen the box-feeding system in operation are hereby assured by the writer, who has carefully watched its effect, that it is in every respect consistent with perfect cleanliness, and perfect health of the

beasts; and he must, without hesitation, state his belief that, whenever any objection has been raised to the system, it has been induced from having seen boxes of improper construction and fitting, or perhaps from excess of moisture produced from rain from above or from springs from beneath. As to the latter observation, respecting excess of moisture, the writer is certain of the fact, that a sufficient quantity of dry litter supplied three or four times a week, to keep the animals clean from the solid excrement, is sufficient to completely absorb the whole of the urine they void. Before having had an opportunity of judging correctly of the fact, the writer was certainly of opinion that supersaturation of the litter with urine would soon take place, but thorough conviction of the contrary has been induced by actual experience. * * * * The writer is so thoroughly convinced of the important advantages to be derived from feeding cattle in separate boxes, under cover of a roof, that he suggests that system as the best he ever witnessed or heard of, in the plan he submits to the Society in competition for their valuable premium for the best essay on farm buildings."

I have quoted Mr. Ewart as an able advocate of the system of feeding cattle in boxes; but, as I have before observed, there is considerable difference of opinion upon this subject, and Mr. John Caird, of Baldoon, whose opinions *on practical points of his profession* ought always to be listened to with attention, evidently prefers stall feeding to any other system, for, in his book describing a tour through the West of Ireland, he has the following remarks on stall feeding:—

"A considerable comparative experience has convinced me that no other method will give equal accommodation for the same outlay; whilst I am also persuaded that, in regard to economy of food and litter, facility of labour in attendance, health and progress of the cattle, and systematic arrangement altogether, stall feeding is superior to any other that has yet come under my notice. The progress of the soiling

system, or house feeding of cattle in summer as well as winter, will lead to a more general recognition of the superiority of stall feeding, both from the necessity of economizing litter and the advantages of not wasting the labour of the cattle feeders and others in traversing unnecessary distances while attending to the stock."

## COW BYRES.

The arrangement of the stalls described as for fattening bullocks will answer the purpose equally well for milch cows. Not so the cattle boxes, though boxes are occasionally used for the purpose.

The stalls for cows should not be less than 8 feet square, to hold two cows.

If a travis is placed between each pair of stalls, it is better to construct it of wood—stone being injurious to the cows. The manger should be about 20 inches from the floor, although often placed on the ground; but Mr. Stephens considers this plan "highly objectionable, inasmuch as when biting the turnips the head of the animal is depressed so low that an undue weight is thrown upon the fore-legs, and an injurious strain induced on the muscles of the lower jaw."

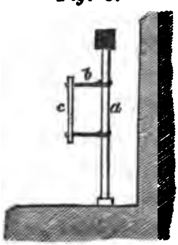
The arrangements for feeding milch cows are pretty much the same as those for beasts. A plan is often adopted, in the North of England, of supplying the animals with their food through a hole in the wall, opposite their heads; but draughts of cold air, entering through the opening right upon the animal, must be highly injurious. Decidedly the best plan is to have a pathway between the wall and the animals' feeding trough.

In some recently erected cow byres the animals are arranged in two rows, with their heads towards each other and a path between them; but there are several objections to this plan, especially that of the animals continually breathing upon each other. The paving of the cow byre should be

with pitched stones for about half the length of the stall, and the other half should be of rammed earth; as cows, in lying down or rising up, first kneel on their fore-knees, which would be injurious if the floor were not made smooth as well as covered with litter.

The method of fastening the cows is the same as for bullocks, viz., a chain with a ring sliding up and down the head post, or a chain and ring, and a strap round the animal's neck. The Scotch plan is generally by what is called a Bakie, shown in figure 5. This is composed of a piece of hard wood, *c*, with two pieces of cord fastened at the top and lower end; the bottom cord has an eye spliced in the end and round the post *a*, up and down which it moves freely. The upper cord has an eye and knot, *b*, where the animal is tied up; the lower end is passed under the neck, and the upper one over; it is then secured to the post. This is a good method of tying up, but not so good as the chain, as the animals are prevented turning their heads to lick their bodies, which they can do by the former plan.

*Fig.* 5.




Another plan of fastening cows, is by a spar of wood shifting in a slot at the top. The animal's head being thrust in when it is open, it is then drawn up to the animal's neck, and fastened. This plan is never to be recommended but for some temporary purpose.

## CALF PENS.

Calves are either suckled by the mother or artificially brought up by hand, by feeding them with milk, linseed tea, &c.

When suckled by the mothers, and there is room enough in the cow byres, they are best arranged in a row behind the cows; and, if not, they are placed in separate loose boxes at

the end of the byres, and let loose at proper intervals to be suckled. Some persons object to the placing the calf cribs in the same byre with their mothers, on account of the elder animals being disturbed by the bleating of the young; but there is no foundation for this prejudice, as in practice it is not the case.

When brought up by hand they are placed in a separate apartment, and sometimes each calf is placed in a separate crib; a plan which has the advantage of preventing them sucking one another, from which bad practice diseases are often engendered. A single calf crib should not be less than 4 feet square and 4 feet high, formed by a frame of light spars, and provided with a wicket for access to the pen. The floor should be paved with some hard material such as asphalte, and every provision should be made for keeping the place clean and sweet.

A most disagreeable smell is always found to exist in the apartments occupied by calves, and no arrangement is ever used to get rid of it; some low shed, without light or ventilation, being generally appropriated for this purpose.

The most ample ventilation should always be secured, by the apartment being of a sufficient height, and provided in the ceiling and roof with an aperture covered with perforated zinc. The walls should be periodically lime-washed, and the apartment be kept thoroughly clean.

In Marshall's Survey of Gloucestershire, he describes the plan adopted for feeding calves; and as it is much used at this time, and is, I believe, the original of the system of feeding cattle on sparred floors, as adopted by Mr. Huxtable and Mr. Mechi, I have given it below. Mr. Huxtable, however, has the credit of being the inventor, although the plan has been used in Gloucestershire from time immemorial.

The calf pens in Gloucestershire, Marshall observes, are of admirable construction, extremely simple, yet singularly well adapted to the object. Young calves, fattening calves more

especially, require to be kept narrowly confined; quietness is, in a degree, essential to their thriving. A loose pen, or a long halter, gives freedom to their natural fears, and a loose to their playfulness. Cleanliness and a due degree of warmth are likewise requisite in the right management of calves. A pen which holds seven, or occasionally eight calves, is of the following description: The house or roomstead, in which it is placed, measures 12 feet by 8; 4 feet of its width are occupied by the stage, and one foot by a trough placed on its front, leaving 3 feet as a gangway, into the middle of which the door opens. The floor of the stage is formed of laths about 2 inches square, lying the longway of the stage, and 1 inch asunder. The front fence is of staves, an inch and a half in diameter, 9 inches from middle to middle, and 3 feet high, entered at the bottom into the front bearer of the floor (from which cross joists pass into the back wall), and steadied at the top by a rail; which, as well as the bottom piece, is entered at each end into the end wall. The holes in the upper rail are wide enough to permit the staves to be lifted up, and taken out to give admission to the calves; one of which is fastened to every second stave by means of two rings of iron joined by a swivel, one ring playing upon the stave, the other receiving a broad leathern collar buckled round the neck of the calf. The trough is for barley meal, chalk, &c., and to rest the pails on. Two calves drink out of one pail, putting their heads through between the staves. The height of the floor of the stage from the floor of the room is about one foot. It is thought to be wrong to hang it higher, lest by the wind drawing under it the calves should be too cold in severe weather: this, however, might be easily prevented by litter or long strawy dung thrust beneath it. It is observable, that these stages are fit only for calves which are fed with the pail, not for calves which suck the cow.

This plan approaches very nearly to the sparred floors of Mr. Huxtable. The main pit being made deeper is decidedly

an advantage. Unless it be raked out every day, the pit will require to be sprinkled with some fixer, as often as convenient, to keep the place sweet and preserve the quality of the manure. For the details of the construction of these floors, see the chapter on Sparred Floors.

## THE PIGGERY.

There is no animal on which the farmer is more inclined to bestow care and attention than on his hogs. They have always been a favourite stock; their general inclination to fatten, short life, and consequently quick return for the outlay, very justly rendering them so.

As to the best arrangement for the lodging and feeding of hogs, almost every man has some particular notion; sometimes they are to be found lodged in the most costly buildings imaginable, and at others scarcely protected from the weather.

That hogs, as well as other animals, require good and sufficient accommodation, there can be no doubt; it is of the first importance that they be kept warm and dry: modern science has proved that a less amount of food will suffice to produce the same results, when so cared for.

They should also be kept exceedingly clean—for the hog is not naturally of dirty habits—and if provided with plenty of clean straw, and a separate lodging, will always be found in a clean state, and amply repay any extra care or attention bestowed upon him.

The sties should not be too large, and should be open, if possible, to the south; they should be divided into two parts —an open yard, and the lodging.

The yard should be conveniently placed for the removal of the large amount of dung made by these animals; it should be surrounded by a strong flush oak fence, or brick wall, and be securely paved; as these animals will root up and entirely destroy the premises in a very short time, if precaution be

not taken to prevent them. They should also be prevented from seeing into the adjoining yards or lodgings.

The lodgings should be raised above the outer yards, and be well protected from the weather, (rain beating in upon hogs is the worst thing that can happen to them,) they should be well ventilated and drained, and the floor should have a good slope towards the yard.

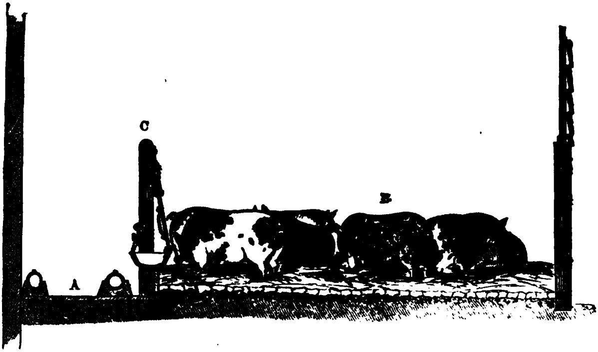
The feeding arrangements are usually placed at the end of the yard, and are loose wood, or iron, open troughs. For small piggeries circular iron troughs, divided into compartments, is a excellent plan. The ordinary triangular troughs in common use are the worst; about one-third of the food being wasted by the hogs splashing it over in their greedy anxiety to get more than their proper share, and sometimes a pig may be seen lying lengthways in the trough, thinking by that means to secure himself a larger share. Such a system of feeding would not be tolerated in any well managed farm, though I am sorry to say it is an ordinary plan. Some contrivance should always exist to separate the hogs and provide for each having its proper allowance, and for the feeder to be able to properly fill the trough before the pigs get at it, which it is difficult to do by the old plan.

An excellent iron trough is made by Crosskill, of Beverley, Tor's patent, for this purpose. The plan is not new, as an extensive and costly piggery, erected at Bagshot Park Farm, by his late Royal Highness the Duke of Gloucester, is fitted with a similar apparatus, but of wood. It is much better to be constructed of iron, if possible, and it should be fitted into the fence, and form part of it.

*Fig.* 6 is the section of a sty, showing the arrangement for feeding.

A, is the passage for the feeder, which will be equally necessary whether the truck and rail be used or not. B, is the lodging for the hogs. This, as well as the outer yard, should be paved in a secure manner, perfectly smooth, and

*Fig. 6.*
*Transverse Section of Piggery.*




without cracks or fissures of any kind, and sloping easily towards the yard.

The floor of the lodging should be worked up to a sill between it and the yard, which should be about four inches lower. Each lodging should slope slightly towards the centre, as well as towards the yard; so as to ensure the most perfect drainage. C, is the post-and-rail fence that separates the hogs from the gangway. The space between the posts is filled up with the hog feeding-trough. This may be constructed of iron or wood, and consists of a circular bottom trough, running the width of the sty, divided by plates across, which prevent the animals pushing one another away, and allows the food to run through the hole at the bottom of it, from end to end, when being filled. Above the centre of the trough is suspended, and swinging, a flap 2 ft. 6 in. deep, which, when the troughs are being filled, is pushed forward towards the hogs and secured there. After the food has been placed in readiness, the flap is withdrawn towards the feeder, and secured to that side of the trough. It then forms an excellent back, and prevents the

least waste from the food being splashed over. In some cases, I have seen this flap fitted to rise in a slot, so that it may be removed from one side to another when the trough is quite full, which, with the ordinary method, cannot be done.

Sometimes these flaps are made of laths; but it is not nearly so good as to have them flush.

## SHEEP SHEDS.

The great success that has attended the system of fattening oxen in stalls, or covered sheds, has led many persons to try experiments as to the effect of the same system, as applied to the fattening of sheep, and generally with successful results; for warm and dry lodging is as necessary to sheep as to other animals.

The gentleman who has carried out this plan on the largest scale, and whose efforts to introduce the system are most looked up to, is Sir Richard Simeon, Bart., on his farm in the Isle of Wight. The plan adopted there is to tie up the sheep separately, exactly the same as bullocks; each sheep having a separate stall, and being fastened with a chain like an ox. The sheep are fed upon oil-cake, cut turnips, meal, &c., from a feeding box, and water is supplied to them from a trough. Behind the animals is placed a manure tank, into which the manure is swept several times during the day. The tank is covered with a grated cover.

The shed is kept at an even temperature, and experience has shown that a much higher temperature than one would expect is the best for fattening. The thermometer, therefore, should be kept exactly at this point.

The plan of shed-feeding is now fast gaining ground, and arrangements of some kind for it are now made in all new homesteads.

Different persons advocate different plans. Mr. Mechi, Mr. Huxtable, and others, have the sheep-shed floors covered with a grating, through which the manure falls, and is occa-

sionally removed. For a description of these floors, see chapter on Sparred Floors.

On some farms the sheep are fed in sheds, the floors of which are excavated below the level of the ground, the same as for box-feeding large animals; the litter is spread over the dung, which is first sprinkled over with dry ashes, gypsum, burnt clay, or some other fixer. This plan is in no way so good for the sheep as the other, which may be called the dry plan, nor is it much in use.

The ordinary mode is now to have large, comfortable sheds, with hard paved floors, in which the sheep are supplied with food in much the same way as in other places, but with this difference, that the animals have full liberty to move about.

It may easily be imagined that the dung from animals fed in this way, that is, under covered sheds, is found to be of the utmost value as manure, and that it has greatly the advantage over the field plan, where half the value of the manure is lost from evaporation of the ammonia in warm weather, and the washing it is subjected to in wet. The important argument formerly brought against this plan on light lands, viz., that the consolidation of the soils by the tread of the sheep was lost, now no longer holds good, for nearly the same effect of the tread of the sheep is produced by the use of Crosskill's toothed roller.

A good arrangement has been made by tying the sheep up in pairs; and, in consequence of the sociable nature of the animal, benefits are said to be derived from it. Economy in construction also takes place, as only one water and feeding trough is required instead of two, and a larger number of sheep may be accommodated in the same sized shed.

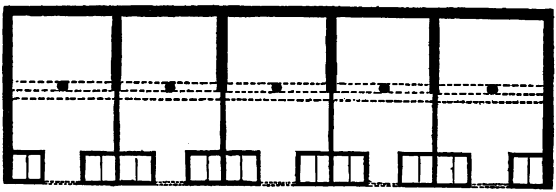
On wet farms there is no doubt that the sparred floor sheep-sheds are most excellent, and of the greatest possible advantage, as the sheep may feed on the land in the day

without injury, if certain of having a thoroughly dry bed at night: their occasionally being wet is of no consequence, the mischief is in their being continually so.

*Bull House.*—A separate box must be provided for bulls, which may be constructed in the same manner as for fattening oxen, except that it should not be less than 12 feet by 9.

*Cattle Hammels.*—In many parts of the north of England, and generally in Scotland, the plan is to feed cattle in hammels. These are small apartments with little yards attached, in which one or more animals are placed, and usually suffered to range in and out of the yard as they please. There needs no particular description of these buildings, as they have no particular fittings up or arrangements, more than an ordinary small shed and yard. Their chief use is in affording accommodation for growing stock; and on farms where much is bred it is necessary to have them. Young growing animals will not thrive so well if subjected to much confinement.

*Fig. 7.—Plan of Hammels.*



*Cattle Infirmary.*—This is a new feature in farm homesteads; but, nevertheless, I think no good steading will long be without it. The dreadful ravages that have taken place lately (especially since the introduction of so much foreign stock) render this building now positively neccessary, with a view to prevent the spread of dreadful disorders. By pleuro-

pneumonia alone a large amount of stock has been destroyed, and in this, as in many other diseases, it is of the utmost importance to have the animal supposed to be affected immediately removed to a separate lodging and yard, inaccessible to any portion of the other stock upon the farm. Different animals require different and peculiar treatment, while suffering from certain diseases, and this can only be effectually carried out by having separate and fit accommodation for them. The cattle infirmary should be placed at some portion of the steading, not in the road of the ordinary stock, and having a separate way to it, and be so situated that the manure from the animals in it may be removed direct to the dung heap or house, that the feet of other animals may not come in contact with it.

The buildings should consist of a loose box for horses, a stall for oxen or cows, a sty and yard, and a small lodging and yard for sheep, surrounded by a high close fence. The floors should be laid with Kamptulicon, or asphalte, as being the least absorbent materials in use. The walls and ceilings should be plastered, and floated as smooth as possible. The troughs, racks, and mangers should be of iron; and wherever there is any woodwork that may come in contact with the sick animal, it should be planed smooth. The whole place should be lime-whited every time cattle are placed in it. Some arrangement should be made for producing extra warmth, if necessary, and the whole should be most perfectly ventilated.

## STRAW YARDS.

In the plans of old steadings the buildings are generally arranged round an enclosed area, called the straw yard, and this yard will be found to exist at the present day, with all its abominations, on nine farms out of ten in England, especially in the south.

It is in this yard that the generality of farmers consider that

the manure is to be made for producing the crops, from the sale of which they are to meet the expenses of the farm, themselves to live, and get, if they can, something towards increasing their capital. One would think, as so much is to be got from this part of the premises, considerable pains would be bestowed in having it constructed and arranged in the best possible manner for the purpose required; but it is not so—the straw yard of most English farms is a partially enclosed place not paved, nor even the bottom formed to any regular shape, unfurnished with any means of draining the liquid manure towards a tank, or protected from the rush of water descending into it from thousands of feet of roofing that surround it, after heavy rain or the melting of snow. Into this yard, or rather pool of stagnant water, tons of valuable fodder in the shape of straw are thrown to form a bed for the stock who are unfortunately doomed for a time to wallow in its filth. The whole of the rain water being allowed to drain into the yard would of course soon flood it, in spite of the continually renewed layers of straw that are added, fresh and clean and dry, to be water-rotted, saturated, and wasted.

To prevent this accumulation of water at the lowest point, it is usual to have a horse pond, into which the water, after thoroughly washing the manure and extracting from it its most valuable elements, eventually finds its way; and the drinking pond, instead of being wholesome and clean, is a rude tank of diluted liquid manure. When this exceeds a fixed height, as it will do of course after every shower, a noisy little torrent makes its way to the adjoining brook, carrying past the farmer's door the very profit that he is working so anxiously to obtain. This wretched straw yard is about the worst part of these miserable steadings, and the farmers are not always to be blamed for it. I have frequently pointed it out to them, and invariably the reply has been "What can I do? the whole of my buildings must have gutters to carry off the rain water, before these gutters are fixed the broken eaves of the buildings

must all be repaired. I must also have spouts and drains to carry off the water clear of the yard. Until this is done, how can I have liquid-manure tanks? I should be glad of one; but you would not advise me to lay out my own money on such improvements without a lease, and my landlord will not do it for me." This is all perfectly true, and the sooner the question is settled between landlord and tenant the better. Tenant farmers are taunted by free-trade journalists and others, because they do not save their liquid manure; but until other arrangements and improvements are made, that ought to be done by the landlord, the tenant has no power to save that which he well knows is running to waste. But I fear we are running away to the question between landlord and tenant, and from the subject in hand,—viz., straw yards.

In the modern steadings a large straw yard is thought unnecessary, small enclosed yards for different descriptions of stock being preferred. These yards should be all properly paved with some hard material, and sloped gradually towards the centre—here there should be an iron grating, and beneath it a cesspool and pipes to convey the liquid manure to the tank. When these yards are bounded by stables, byres, &c., a raised foot-path should run round them, protected from the muck by a curb, so that proper roadways may everywhere exist to give facility of communication between different buildings, which is a matter of the first importance.

Straw or fold yards should always be, if possible, enclosed on the north, east, and west sides, and open towards the south; there should be no open places between buildings through which draughts might enter, and all wooden fences and gates should be made with flush-boards.

An open shed should be built in the centre of the yard, if none exist at the sides, that the stock may have shelter from the rain if they choose to avail themselves of it, which they will generally be found ready enough to do.

## POULTRY HOUSE.

When only a few fowls are kept that have the run of the straw yards, &c., no particular accommodation is required beyond a small apartment, furnished with a few boxes for the hens to lay in.

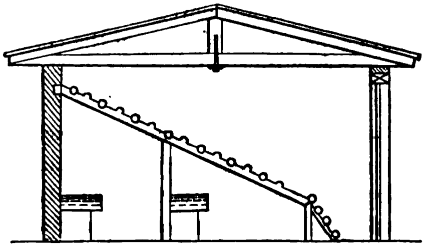
But sometimes it is made part of the regular business, and a large stock of poultry of various kinds bred and fatted for market. In this case a proper building should be constructed, of ample dimensions, perfectly water tight, and inaccessible to foxes, cats, and other vermin. The place must be paved with stone, asphalte, or brick in cement, laid perfectly smooth. There must also be efficient drains to keep the whole dry.

The aspect of the poultry house should be either to the east or south-east, so as to receive the first of the sun's rays in the winter. In order to carry out the breeding and fattening of a large quantity of different kinds of poultry in a proper manner, it is necessary that each species should have a separate apartment to be entered by its own door. A yard should be provided into which the fowls may disperse themselves during the day. There should also be provided a proper pond for aquatic birds. The roosts for hens, turkeys, &c., may be placed over the lodgings for aquatic birds. Arrangements should be specially made for excluding the excessive heat of summer, and the intense cold of winter.

If the situation is at all exposed, it is better to have a flue, or some other arrangement, for warming the place. A small sliding trap should be placed in the bottom of each door, to allow of the ingress and egress of the birds when the doors are closed.

It is usual to place the battens at angles across the fowl houses for the fowls to roost upon; but the most efficient plan is to have a series of rough angular spars, rising one above another, from the floor to the roof, as in *Fig.* 8.

*Fig.* 8.—*Section of Fowl House.*



The nests are generally small niches or divisions placed against the wall in rows one above another. In front of each tier of nests, and level with the bottom of the nest, must be a small projecting stage about a foot in width. A step ladder must be provided for the birds to reach it. The slope of the roosting stage is usually placed at an angle of about forty-five degrees.

*Pigeon Houses.*—The keeping of pigeons is not at all consistent with good farming, unless it be in grazing districts, where there is no chance of damage being done to corn.

Pigeon houses are generally used as ornamental appendages to the stable yards or out-buildings attached to the residences of private gentlemen, and usually consist of a box divided into compartments about 18 inches deep, and a foot wide and high. The compartments are arranged in pairs, one being open at the front and the other closed. These boxes are generally placed on poles, which are fixed in the centre of the yards; or where a great number are kept, a regular building is erected, either standing alone or raised above the roof of some barn or stable.

It was the custom formerly to keep pigeons to a much larger extent than is now done; and the quaint little buildings we often see with high-pitched roofs standing alone, or

at a short distance from the farmery, were erected for this purpose.

The circular conical-roofed dovecot of the old French Seigneurie is always a prominent feature in the landscape of that country.

*Rabbitery.*—Rabbits in any quantity are seldom to be met with as a part of the live stock of the agriculturist*.

When so kept, their accommodation consists of a series of yards and sheds much the same as a piggery; but not so large.

*The Apiary.*—The ordinary plan of keeping bees is by placing the hives in the open air upon a stool. One leg is considered better than more, as giving greater protection from insects or vermin. The leg of the stool is driven into the ground, and upon the top of it, secured by a spike nail, is a piece of slab upon which the hive is placed. This is usually made of straw twisted and plaited; but of late years a great deal has been written about the management of bees, and a number of scientific hives invented. Some of these have glass windows for inspecting the operations of the insect, and others are divided into series of cells and arranged in stories; but the old straw hive is still a favourite with those who pay most attention to the subject.

The situation of the hive stool should always be in some sheltered corner, having fences or walls on two sides (to pro-

* Although the manure from these animals is of great value, and some farmers have found it worth while to keep them for this purpose. I see for instance, by Mr. Mechi's model of his farm, that he is keeping a quantity, and I have no doubt but he will make known the results of his experience, and his method of rearing and fattening them.

Rabbits fatted for market are placed in hutches; that is, small boxes divided into two compartments, one of which is faced with spars of wood about an inch apart, and the other is closed to the front and has an opening from the other compartment.

tect the swarm from winds, &c.), and being open to the south and west.

When there are a number of stools, they should be arranged in rows about three feet apart, those in the second row alternating with those in the first.

To protect them from being stolen, where the situation is accessible to strangers, the hive is secured to the stool by a chain and padlock.

When a large number of bees are kept in the neighbourhood of a mansion, or associated with buildings of an ornamental character, an apiary is often built.

This is a building for containing the hives, which are placed upon shelves one above another.

These little buildings are made in a variety of forms, according to the fancy of the proprietor. Bees, however, are generally considered to thrive best in the open air, as before described.

## CHAPTER III.

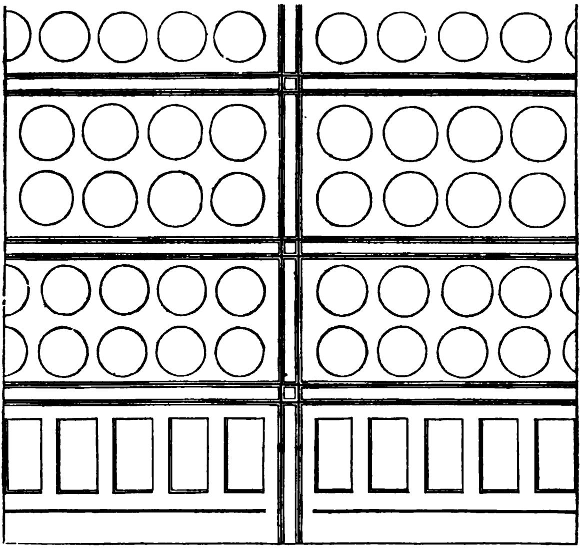
### RICK YARD.

The rick yard, as the name implies, is the place in which the various crops, grain and hay, are placed after they have been harvested.

The rick yard should be a level piece of ground, and thoroughly dry; the stacks should be placed on frames of wood or iron, called staddles. These must be arranged in such a manner that any one particular stack may be got at when it is necessary, according to the judgment of the farmer, as to whether its condition requires that it be immediately used, as in the case of its heating, or whether he requires it for consumption on the farm, or a good price may be got for it at the market.

The best plan of arranging stacks in the rick yard, is as shown in *Fig.* 9.

*Fig.* 9.—*Plan of Rick Yard.*



It will be seen by this plan, that any stack in the yard may be got at; and if a railway be laid down from the entrance to the threshing barn, the truck may be placed alongside any rick.

It is acknowledged by all, that railways should be laid down in farmeries, to facilitate the business of the farm, wherever judicious. Now, the great weight of the straw, which has to be removed to the threshing barn, renders the plan, in this case, highly advantageous. The plan of the stacks shown in the cut might be objected to, on account of its requiring a turn-table at every cross, which would occasion considerable expense; but I have been able to obviate this difficulty by constructing a particular sort of truck, especially adapted for this purpose. (For a drawing and description of this, see

Vol. II.) It is a truck so constructed as to be able to run from one line to another at right angles to it, without the aid of turn-tables.

Mr. Moreton, to get over this difficulty, and avoid turn-tables, has the line of rails leading to the threshing barn sunk below the surface of the ground, and on this a truck runs, the top of which is level with the cross lines. The truck on the cross lines, being loaded, is run on to the truck in the sunk line, and the two trucks, and their load, one on the top of the other, are run up to the threshing barn. This plan, though extremely ingenious, is for several reasons very inconvenient, and it is to obviate this inconvenience that I have designed the machine before alluded to.

## THE BARNS.

The largest and most important of the various buildings forming the steading, is the threshing and store barn. In old steadings this building, from its great size and picturesque shape, is always an imposing feature; its high pitched-roof of thatch or tiles, covered with moss, and its quaint gables as seen above the trees, render it one of the most striking features in English landscape, and one which has always been a favourite with painters.

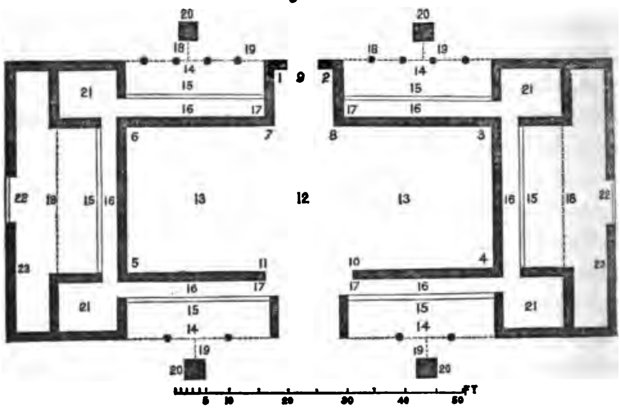
Some of these old barns, designed by early English architects, are most skilfully constructed, and often have considerable architectural pretensions. Such as the barn at Thornhill Old Hall, Yorkshire, which is a very fine specimen; and another very fine barn of brick at Old Basing, Hants, formerly attached to the fine mansion of Old Basing House, destroyed by Cromwell. There are many similar ones to be met with in almost every county in England.

These barns are generally divided transversely into three principal divisions, the centre one being the threshing floor, and the two side ones for the mows of unthreshed grain. The roof of the building is generally carried a considerable distance, eaves fashion, below the side-wall plates.

Small lodgings for stock are formed under them; and one or two small apartments in the interior, for storing the clean straw, &c.

One of the best plans of a barn of this description is shown in the annexed woodcut, and was designed for General Washington, by Arthur Young, Esq. :—

*Fig.* 10.



1, 2, 3, 4, 5, 6. The barn.
1, 2, 7, 8. The porch of ditto, with a small door at 9.
10, 11. The great door at which the carts enter.
12. The threshing floor, which extends the space of 1, 2, 10, 11.
13, 13. Bays in which the corn is stowed.
14, 14, 14, 14. Sheds for cattle and horses.
15, 15, 15, 15. Mangers out of which the cattle get their roots, straw, and chaff.
16, 16, 16, 16. Passages, between two and three feet wide, for carrying food to the cattle.
17, 17, 17, 17. Doors in the passage.
18, 18, 18, 18. Principal posts on which the shed rests.
19, 19, 19, 19. Gutters of brick sloped, for conveying the urine of the cattle to
20, 20, 20, 20. Cisterns, from which it is every day regularly thrown on the dunghill.
21, 21, 21, 21, are sheds for various purposes.
22, 22. Two yards, with each a shed for shelter, to be applied to any purpose wanted: one for sheep, surrounded with low racks; another divided for a horse or two loose, or the other half for yearling calves.
23, 23. Enclosure of pales.
1, 2, 3, 4, 5, 6, 7. The main body of the barn, which rises from 14 to 20 feet to the eaves: all the rest of the shed being placed against it.

This specimen represents the general style of ancient barns, as all of them partake more or less of its character. The ancient method of housing the whole produce of the farm in barns, and the old mode of threshing with the flail, rendered this description of barn necessary to every steading; but the introduction of the threshing machine, and other arrangements for economizing and accelerating the barn operations, render this large costly sort of barn now generally unnecessary.

Nevertheless, there are still some situations in which small barns of this description may be judiciously erected, and some crops, that in the present state of the threshing machine it is better to thresh with the flail—such as barley for malting, and to procure straw for thatching; it is therefore better to make arrangements to have a threshing floor properly situate, in the event of its being wanted.

The introduction of the thrashing machine so totally alters the working arrangements of the barn, that entirely new and different sorts of barns should be erected in all new steadings; and the great importance of threshing well, with economy and despatch, renders this building of the utmost consequence.

The most judicious situation having been chosen for the erection of the threshing barn, the next point is the application of motive power. Should this be water, this building will be dependant for details and arrangements entirely on locality; if steam, or horse-power, a fixed principle may be laid down, and in fixing this principle, it will be necessary to consider what are the operations to be performed, and the requirements for performing those operations in the best and most economical manner.

In the old manner of housing crops, it was the custom (as has been before observed), to place the whole, or nearly the whole, in large barns. The present plan, on account of much larger quantities of grain being got from the land, and the introduction of the threshing machine, has been to store the

grain crops in stacks or ricks, sometimes in the fields where the crop is grown, or a convenient place near, or else to place all the stacks in a piece of ground called a rick yard, in a convenient situation with reference to the threshing barn, and it is with this plan we have chiefly now to deal.

The first requisite of a well-arranged threshing barn should be, that the unthreshed straw be easily conveyed direct to the head of the threshing machine, and that facilities be afforded for removing the straw back (after it has passed through the machine) to the rick yard.

In a number of example steadings, there has been a great error committed in not placing the machine in such a situation that the straw may be easily and conveniently stowed away after leaving the machine. In Mr. Mechi's costly steading, at Tiptree Hall, the store barn is of enormous size; but, after the powerful threshing machine has done its work, there is no corresponding place for housing or removing the straw.

I should not, myself, in constructing a steading, erect any building for storing unthreshed straw, or housing any quantity of threshed straw; but farmers, I know, like barn room, and would be a long time before they gave up their prejudice in favour of it.

In a large steading I constructed in Hampshire, I had no place to house the crops. The waggons delivered it at once to the machine, and the straw was again removed to the rick yard. I found no inconvenience from this plan, and I would sooner be without large barns, than have to pay interest of money for them.

It is of great importance that facility be given for supplying all courts, yards, and lofts with the straw necessary for litter.

The centre portion of the building, which contains the threshing machinery, it is necessary should be constructed in a very superior manner; and it being admitted that fixed machinery is the best and most economical for all purposes, I

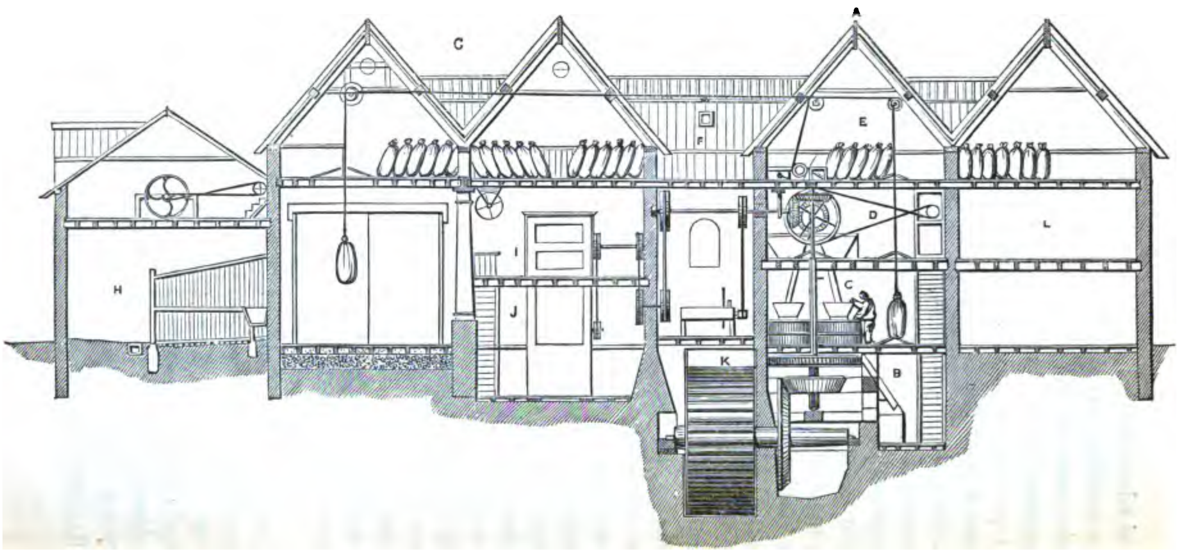
should advise that all machinery that possibly can be placed in this building, and that it be constructed and fitted up with superior materials and workmanship, and should also contain the granary and stores for everything of value, and be rendered perfectly inaccessible to vermin and thieves. For this purpose it should be divided into three floors, as in Plate 8.

A, being the pit, or lower floor, upon which are placed the winnowing machines and cleaning machinery. B, the stage floor, strongly secured and supported, upon which are placed the threshing and other machines. C, is the granary and store room. D,D, is the line of the roadway through the barn, upon which the waggons pass to deliver straw to the machine, the grain falling through to the winnowing and cleaning machines; it is then hoisted by a sack tackle to the granary above, in which are placed a series of hoppers for delivering the various materials to the machines below—such as oil-cake to be crushed; beans, oats, &c., to be bruised; corn to be ground; and wheat, when necessary, to be cleaned by passing through the smut machine. These various articles, after passing through each machine, are delivered into bins, or troughs, on the first floor, A.

Having constructed a threshing barn, granary, &c., very nearly the same as described above, upon this plan, I am able to speak from experience as to its successfully answering the purpose intended. The annexed plate represents the section through the buildings. They were constructed for and under the direction of Joseph Gibbs, Esq., an eminent civil engineer. The materials, workmanship, and fittings-up of the machinery were all of first-rate character.

A, is the corn mill, consisting of the pit floor; B, the hurst, driving gear, and meal bins; C, is the stone floor, with three pairs of stones and pastry at back; D, is the dressing floor, with dressing, bolting, and smut machines; E, is the top floor, containing the sack tackle, hopper, and shoots to the floor below; from this floor there is a covered gangway to connect

# Plate XIII.



the top floor of the threshing barn, C, with it, the whole top floor forming on one level a convenient and extensive granary and store; from this floor there is a communication to the loft, over the stables, H, in which is placed the chaff-cutting machinery. The threshing machine is placed on a stage floor, I, in the threshing barn, and beneath it the winnowing machine, the floor being sunk for that purpose.

The straw is delivered at the side of the machine from the waggon, a roadway being constructed through the barn. Attached to the gear in the mill a sack tackle is fixed in the granary for the purpose of hoisting from the waggon below. In the rear of the threshing barn, and at right angles with it, is the straw barn; between the threshing barn and the corn mill is a circular saw bench.

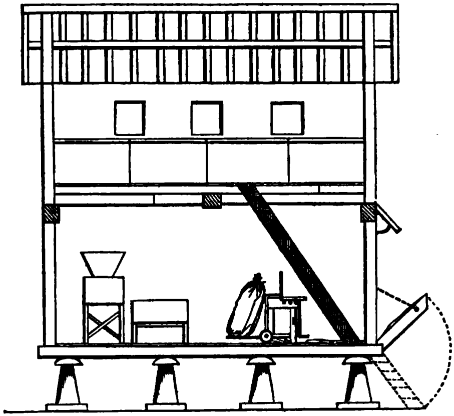
The whole is driven by an overshot water wheel, K. L, is the dwelling house of the miller.

The ground plan of these buildings was not quite what one would have wished; the formation of the mill tail in a deep cutting and other local circumstances prevented its being otherwise. In making a new design for a threshing barn, &c., therefore I have adopted as much only of this as was found to answer well, and made my other arrangements as I could have wished, had I a clear piece of ground to build upon, and no old buildings to adapt. In the design for a large steading, Plate VI., I have still kept the same arrangements for the threshing barn and granary, the difference being in those of the straw barn.

## THE GRANARY.

The most common form of granary to be met with in old farmeries is a small detached building, sometimes of brick or stone, but generally of wood; placed upon staddles, and standing isolated, in or near the farm yard. The reason for placing it thus, was to render its access as difficult as possible to vermin. *Fig.* 11 represents a section of one of these descriptions of granaries on rather a larger scale than usual,

*Fig.* 11.—*Section of Granary.*



and one of the best of its kind. It was designed and constructed by Mr. Robert Burgess, at Brook Farm, Hants.

It contains two floors, with bins for grain, and a variety of other conveniences; it is also fitted with a sack tackle, scales and weights, and has a small hand corn-grinding mill and dressing machine.

The introduction of the threshing machine having considerably altered the shape and construction of the threshing barn, now renders this form of granary but ill adapted for the purpose, and I have therefore placed it over the threshing machine, and it becomes in all respects a place similar to the top floor of corn mills.

## THE CHAFF HOUSE.

The advantages derived from feeding animals with cut fodder may now be considered as settled, and the chaff house to be a necessary adjunct to every steading.

This apartment should be so placed that the greatest facility be given for supplying the machine with the hay, straw, &c., to be cut, and should therefore be in such a position as to be

in direct communication with the hay and straw barn. It is also necessary that it be so placed that equal facilities be given for the supply of the chaff to all the animals on the farm consuming it.

As the chaff-cutting machine requires considerable power to drive it, and is in daily use, of course the motive power used for the threshing and other machinery is also required for this. This point must of course be properly considered in fixing the site of this apartment. A common plan in modern steadings, has been to place the chaff-cutting machine upon the stage floor of the threshing barn, and in consequence of this, the operation of cutting and preparing the chaff I have observed to be always done in an unsatisfactory manner. This has been done to avoid carrying the power (which is usually placed close to the threshing machine) to a more distant point; but as a light lay shaft, or riggers and straps, may be set up at a small cost, and very little loss of power (if within a reasonable distance), it is never worth while to have the chaff machine placed on an inconvenient site to avoid it. In the example steading at Plate VI. the chaff house is placed at the end of the bullock shed, so that the truck upon the tramway has direct communication from the chaff machine to the steaming apparatus and the feeding troughs of the animals. The walls of this room should be plastered, and a good window, with moveable sashes, so placed as to get rid as much as possible of the dust which is beaten up in cutting inferior hay.

*Root Stores.*—The storing of roots for stock is a matter of very great importance, and few things are more indicative of a well-managed steading than the manner in which roots are preserved. The buildings for this purpose should be exceedingly dry, and well protected from frost. They may be made of any convenient shape, and should be placed in situations the most contiguous to the places where they are required; but as the notion is now gaining ground that a railway should be laid down to connect the various divisions of the homestead with

each other, it is not so important where they are placed, so that the locality be the one best suited for the preservation of the roots. Convenient arrangements should exist for unloading the carts when they are brought from the fields. The stores should be of such a shape that the roots may not be laid in too large heaps, as they are more likely to rot when so packed, and there is the more difficulty in removing those that do not. It is very necessary that a proper ventilation should exist for root stores; a close pent-up atmosphere is the one in which decomposition takes place most rapidly.

*Root-washing House.*—This apartment should adjoin the cooking house, and is for the purpose of washing the various kinds of roots, previous to their being cooked for the stock. This is a point not often properly attended to, and considerable waste often occurs in consequence; a liberal supply of water should be laid on and proper troughs provided, and the necessary apparatus for washing be placed here. The various root-washing machines (of which there are several kinds) will be found fully described in Part II., on the machinery and implements of the steading. The room should be well paved, and a sink and drain provided.

*Boiling House.*—The advantage of feeding animals on cooked food is now beginning to be thoroughly understood, and scarcely a farm is to be found without some arrangement for effecting this object. On farms of any pretension to good management a proper building is provided, fitted with everything necessary for boiling, steaming, and even baking the food to be supplied to the animals.

It is now well known to all farmers of intelligence that the potatoe is rendered of much more value as food after being cooked, either by boiling or steaming, or what is more preferable, baking. In fact, baking is the only true way to cook potatoes, there being a bitter juice exceedingly unwholesome in the skin (and slightly in the potatoe itself), which is not got

rid of in boiling; hence the extremely bitter taste of the skin of the potatoe after it has been boiled, but after having been baked it is entirely rid of this disagreeable material, and tastes equally well with the other part of the root. Human beings cannot eat the skins of boiled potatoes, and it is no proof that animals, even hogs, like it because they eat it. For horses, potatoes should always be baked, as they are thereby rendered drier and more nutritious.

In experiments made on a large scale on the keep of coach horses, a most important saving was effected by giving the horse a large portion of the hay steamed. All inferior food or bad hay is immensely improved by cooking. An instance of this came under my notice, a short time since, at Biddulph-Hall Farm, Cheshire. The proprietor, in my presence, offered to several well-bred cows portions of heated black hay which were refused by each animal; but, after the same hay had been placed in a wooden chest, and a jet of high-pressure steam allowed to pass through it (which entirely removed all the bad odour), each animal ate it in preference to good clover-hay which was offered them at the same time uncooked.

*Fuel House.*—This need only be an ordinary shed, with one side open, that carts, laden with any kind of fuel, may back up to, and shoot right into it. It should of course adjoin the boiling house.

*The Dung House.*—It is presumed that the farmer is now fully aware of the value of ammonia as a fertilizer, and that it is the peculiar property of this valuable article to evaporate and fly off at an extremely low temperature; also, that the pungent smell in stables, by which the cattle are so much injured, and himself made uncomfortable, is caused by the evaporation of ammonia. Now, being aware of these facts, it may be supposed that he will not spare any trouble or proper expense in endeavouring to retain and econo-

mize every atom of this valuable material; and it is also presumed that he is aware of the fact, that the brown liquid that runs from the dung heap and cattle sheds contains in solution the most valuable fertilizing elements of his manure.

He, being aware of this, will not object to the introduction of dung houses and liquid-manure tanks. The latter are indeed now to be found everywhere in modern steadings, but the necessity of a dung house has not yet become so apparent. In Scotland, they are quite common; but in England, it is only on what are called "example farms" that they are to be met with. It is quite certain now, that farmers will have to farm higher to meet the present altered state of their affairs, and this they can only do by making more manure, and taking much more care of what they do make: for all know that upon the quantity of manure you employ will depend the quantity and quality of your crops; and that it is impossible for farmers to farm high without it. It is therefore hoped that no apology need be made for placing the dung houses, or pits, among the offices necessary to every farm steading.

The best plan for erecting a dung house is to excavate a long piece of ground, about 6 feet in the centre, and slope to the surface at each end. It should be about 12 feet wide, and be lined and paved with brick, and coated with Roman cement at the lowest part. In using the word dung house I do not mean to recommend a covered building, but a properly constructed depôt in which the manure shall be so circumstanced as to receive no injury from rain water. Mr. Caird says that he considers a covered dung house as the most important part of the whole steading, but equally eminent authorities entirely disagree with him. H. S. Thompson, Esq., one of the judges of the prize essays of the Royal Agricultural Society, in his review of these essays thus disposes of the question:—"The objection to covered manure pits is, the lightness of the manure, and its consequent tendency to heat itself dry with very great loss of ammonia. It certainly may be watered from a pump or tank, but this would only increase

the fermentation so long as the heap was light; and to meet this difficulty it has been suggested that it should be frequently carted over. It is certainly possible, by carting or some other mechanical means, to give sufficient solidity to prevent mischief, but when the trouble and inconvenience of carting over a partly decomposed heap, and also the probability of its being neglected in busy seasons, are taken into account, it will probably be found that in the majority of cases covered manure pits would do more harm than good."

*Manure House.*—If much artificial manure be used on the farm, it will be necessary to have a separate apartment for storing, mixing, and measuring it; it should have a hard paved floor, and be provided with scales, weights, measures, &c., &c.

*Liquid-manure Tanks.*—The great value of the liquid excrements of animals is now well understood, and no farmer can be found who would not like to have proper tanks for the preservation of his liquid manure. In fact, tanks for this purpose should be provided for every description of holding, from the smallest cottage to the largest farm. We have before alluded to various reasons why they are not constructed by tenant farmers, and there can be no doubt that every landlord is bound to provide them, as part of the ordinary appurtenances of the farm.

It is usual to place the liquid-manure tank in the centre of the yards; but, as there is no good reason for so doing, I should recommend it to be placed in some convenient spot outside the general boundary of the homestead, which all the pipes from the various courts, hammels, stables, sheds, &c., may deliver to, and that the spot be chosen as conveniently accessible as possible to the farm roads.

If the dung house can be placed near it, so much the better; but few forms of ground plan would admit of it.

Liquid-manure tanks may be constructed of any shape, but

for small farms, a round one is the best and cheapest. This will be constructed in the ordinary manner of building wells; the bricks should be set in cement, and the whole be lined with cement after.

The excavation for the tank should be made much larger than is required for the brickwork, that a good thickness of puddling may surround it, and the same under the bottom; if there be not, it will be found a very difficult matter to prevent soakage into the ground. The top of the tank should be domed over in brickwork, with a man hole left in the centre; this to be covered with a stone having a ring in it. A liquid-manure pump should be placed at the side of the tank, with the usual arrangements for filling carts, or forcing it through pipes, as is done at Mr. Huxtable's and other places.*

* Mr. Huxtable thus describes his plan. Hitherto the expense of cartage has been an effectual impediment to the application of the contents of our tanks, except to a few fields around the homestead; and therefore there has been, so far as I know, no systematic delivery of the precious fluid over all the farm. I have accomplished this, I think, both effectually and economically upon 60 acres of one of the farms which I occupy. It has been suggested that cast-iron pipes would be the cheapest and best channels of conveyance; but I am confident that they would not long resist the corrosive action of the urine at the joints: in proof, I appeal to the escape of fœtid gas from the pipes in every town. I commenced with wooden pipes carefully jointed; and I am very well satisfied with them where they have been tested by an adequate pressure of fluid, and doubt not that larch and elm thus bored will be very lasting. But subsequent inquiry and experiment have led me to prefer well-burnt clay pipes of at least an inch in thickness, and properly prepared for the purpose, and capable of bearing 200-feet pressure without any symptom of moisture oozing through the pores. These pipes, of one inch and seven-eighths diameter, are sold in the adjoining parish of Twerne Minster for 7*d.* per yard. The joints, which are of a peculiar shape, are secured with cement. These pipes are placed about 2 feet underground, and at every 200 yards is inserted an upright column, bored to the same gauge as the pipes themselves. On the top of these a spout, when uncorked, will deliver the liquid; if it be not wanted there, finding no vent, it rushes onwards to the next stump, 200 yards off.

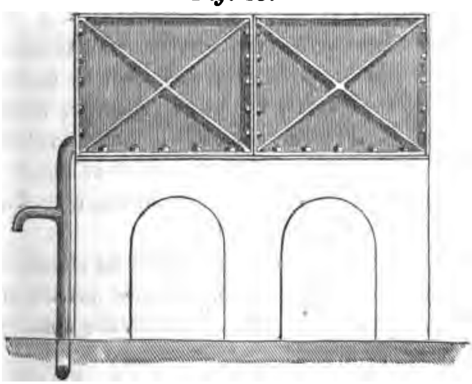
The annexed table shows the contents of various sized tanks in gallons at per foot of depth.

TABLE *showing the Quantity of Excavation, the Number of Bricks required to stein the Tank, and Content in Gallons for every Foot in depth.*

| Diameter in the Clear. | | Cubic Feet of Excavation. | | 1-brick Rim in Cement. | Content in Gallons between Brickwork. |
|---|---|---|---|---|---|
| Ft. | In. | Ft. | In. | | |
| 5 | 0 | 33 | 2 | 192 | 120 |
| 5 | 6 | 38 | 5 | 209 | 145 |
| 6 | 0 | 44 | 2 | 226 | 170 |
| 6 | 6 | 50 | 3 | 242 | 200 |
| 7 | 0 | 56 | 9 | 260 | 230 |
| 7 | 6 | 63 | 7 | 276 | 269 |
| 8 | 0 | 70 | 11 | 292 | 308 |
| 8 | 6 | 78 | 6 | 308 | 349 |
| 9 | 0 | 86 | 7 | 326 | 390 |
| 9 | 6 | 95 | 1 | 343 | 435 |
| 10 | 0 | 103 | 10 | 360 | 480 |

Figure 13 represents a liquid-manure tank raised on brick base, the liquid manure to be pumped into it by the steam engine, as described in page 41.

*Fig.* 13.



*The Dairy* is the place where the milk of the cows is kept, and the room in which the important process of converting that milk into butter and cheese is carried on. A very large number of farms in England are grass farms, and to most of these the dairy house, and anything in connection with it, is of the first importance, as the whole success of the farm will depend on the judicious management of it.

This task is always confided to, and exceedingly well executed by, the female portion of the household. In the constructing of dairy houses the most important points are the following:—First, That it be so placed and built that an equal temperature be preserved throughout the year; the cold of winter being equally injurious with the heat of summer. Second, That every facility be given for preserving the most fastidious cleanliness, by a plentiful supply of water and the most efficient drainage.

On farms where only a small number of cows are kept the dairy is generally a small apartment in the farm house, but on large dairy farms it is a separately constructed building, and should contain three separate apartments below, with cheese rooms above.

The dairy house should be placed, if possible, on a porous soil, and sheltered from north and east winds. The principal apartment is the milk room; the floor of this should be sunk three or four feet below the surface of the ground, and be paved with marble, polished stone, or tiles, and slope towards a drain, from which the water must run freely away; stagnant water, and smells of all kinds, being exceedingly injurious. Indeed, so delicately susceptible of injury is milk, that the smell from cheese, rennet, cooked or uncooked meat, will often cause considerable injury.

About three feet from the floor should be placed, on three sides, shelves two feet broad, of polished marble or brick, upon which are placed the pans to contain the milk.

The best material for dairy shelves is Galway marble, as it is the least absorbent. If the shelves are made of wood, it should be beech or plane tree; these woods being the hardest and most stainless. The ceilings and walls should be plastered. The windows should be covered with fly gauze, and be fitted with Venetian blinds and shutters outward. A lock-up cupboard should be conveniently placed, and the door covered with perforated wire gauze.

*The Churning Room.*—In this apartment is placed the machinery for converting the milk into butter. This is worked in various ways; when large, the motive power of the homestead is employed in driving it by connecting it by a lay shaft, or by bands. When the dairy house is a detached building, a horse wheel is often placed in a shed outside the churning house. The presses for squeezing the curd are placed in this room. As the temperature of the milk, in the churning room requires to be regulated, a steam pipe is introduced from the boiler in the scalding house and applied to the churn. The temperature of the milk room may be regulated in the same way.

*The Scalding Room* should be a roomy apartment properly fitted up with a steam boiler and copper, a rinsing tank and sink. The floor should be paved with stone or brick set in cement, and should have a good fall in every direction towards the drains. An unlimited supply of water should be provided for this. Outside the building it is as well to have a lean-to shed, with benches, upon which are placed the milk pans, tubs, and other utensils, to dry.

*The Cheese Room* is usually placed in the upper floor of the dairy house; it must be dry and airy, or the cheeses will dry unequally and have a spotted appearance, besides being

apt to heave. Cheeses should not be salted in this apartment, nor should wet and dry cheeses be placed together, or much injury will be the result. Shelves should be placed round the walls, and a strong wooden framing should be constructed in the centre fitted with shelves, upon which the cheeses are placed, and in such a manner that easy access may be had for the purpose of continually turning them.

Very large sums of money have occasionally been spent in the construction of dairies by various noblemen and gentlemen, but these have generally been erected as ornamental appendages to the estates, and are not such as dairy farmeries require for the mere manufacture of butter and cheese. We, therefore, need not enter into the details of such; but should any person be inclined to construct one, he will find one of the best examples in an elaborate and beautiful dairy attached to the farm of his Royal Highness Prince Albert, in Windsor Park.

As a specimen of a first-rate dairy, we cannot do better than copy the description of the dairy at Mr. Littledale's farm at Liscard, Cheshire, from the *Farmer's Magazine* for May, 1848:—

"The dairy adjoining is the most perfect and beautiful we have ever seen. It is a large oblong square room, elegantly and usefully fitted up. The floor is formed of Kean's patent cement, of a chocolate colour, and was laid in one piece; but, by white lines of composition introduced, let into grooves made on the surface, it resembles fine pavement in large squares. There are two tables, one on each side, made of sycamore, with turned pillar legs of the same; and the whole of almost snowy whiteness from washing. There is a massive marble table at the further end. Three very large octagonal shaped leaden milk coolers stand in the centre, each on an ornamental pedestal. The walls above the tables, to the height of about twenty inches, are lined with glazed Stafford-

shire tiles, resembling small squares of veined marble. There are ten square ventilators round the sides. The roof is of the pavilion or curved form, groined, with a handsome foliated centrepiece, which, being in open-work, leads the air to a large ventilator at the top of the building. The walls more exposed to the sun are built with a hollow space of three inches in them, through which a current of air passes, and there is a double ceiling, for the same obvious purpose of keeping an equal temperature in summer and winter. The milk dishes are all of glass, of various sizes, and both round and oval. These (glass being a non-conductor) are, for the preservation of the milk, and for throwing up the cream, found to be superior to vessels of the usual materials. The room is, in fine, a perfect model of a dairy in elegance, cleanliness, and adaptation. The milk kits, or pails in which the milk is brought from the shippons, are all beautifully made of sycamore, and are kept so clean that the wood, like the tables, is white and spotless, and the iron hoops of dazzling brightness."

The plan of this dairy will be found in the plan of the Liscard Steading. For the utensils and manner of fitting up presses and churns, see the chapter on the Utensils of the Dairy, Part II.

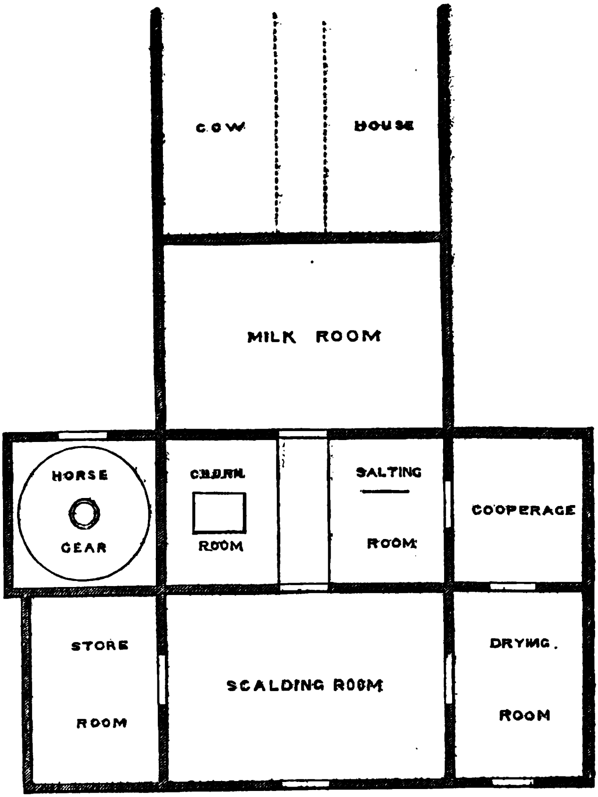
Plate 14 is a plan of a Dutch dairy house, with horse gear attached.

The milk-room walls in Holland are usually covered with small square tiles, white, or with blue pattern. The shelves are of hard grey stone of excellent quality, brought down the Rhine for that particular purpose. The floor is of hard clinker bricks set in cement, or of marble something like the shelves. The process of butter and cheese making in Holland is carried on with great care and skill.

*Wool Room.*—On large farms where many sheep are kept,

PLATE 14.

*Dutch Dairy House.*



it is necessary to have an apartment provided for this purpose, the storing and packiñg of wool being an operation of considerable consequence.

The floor of the wool room should be planed clean, and be of hard wood, the floor boards ploughed and tongued. The walls and ceiling should be properly plastered with hair plaster. It is usual to have three strong beams extending from wall to wall below the plaster of the ceiling, for several purposes. In these are placed strong iron hooks; two of these support the pack line used in packing the wool into canvas bags called packs, and the other is for supporting the beam of the scales during the operation of weighing the fleeces and packs.

A window should be provided with moveable sashes and a shutter, for partially or perfectly excluding the light when necessary. The door should be made large enough to allow of the exit of the wool-packs; six feet in height, and four feet in width, is sufficient. A small closet in one corner with shelves is also necessary, having a proper lock and key for its door.

*Shepherd's Store.*—A small apartment in which the shepherd keeps the various articles used by him, such as medicines, tar, ruddle, &c. This building should be arranged, (if possible,) to communicate directly with the sheep shed.

*Engine House.*—A small separate room should always be appropriated for the steam engine, wherever one is used. It should be properly constructed of brick or stone, paved and plastered; it should have well-fitted windows, and the door should have a good lock and key—the latter being always kept by the foreman when the engine is not in use, so that labourers or other persons who have no business there may be effectually excluded, and tampering or playing with the ma-

chine prevented. I know from experience this to be a very necessary precaution.

For the manner of fitting up the engine, shaftings, &c., in the room, see the article on Steam Engines, Part II.

*Smith's and Carpenter's Shop.*—On very large steadings it is found to be of great advantage to have constructed on the premises a smith's forge, and a wheelwright's or carpenter's shop. They are to be found on many large farms, and always in use. The great loss of time and heavy expense in shoeing horses and doing the smith's work of the farm elsewhere, fully justifying their erection. Something is always giving way or wearing out; and with renewings and mendings the smith need seldom be unemployed. The wheelwright's shop should adjoin the smith's by a covered shed, under which horses can stand to be shod, &c.

The wheelwright should do all the carpenter's work on the farm, keeping all the buildings, as well as carts, waggons, and agricultural implements, in proper repair, and painting them at proper times. He should also be hammerman, and strike to the farrier or smith. Should any leisure time occur, the two can have a new waggon or cart in the course of construction. On large farms, and with judicious management, there is no doubt that the resident wheelwright and smith will save a great deal of time and money to the farmer.

The smith's shop should be not less than fifteen feet square, built of brick or stone, roofed with slate or tiles, and have a floor composed of smith's ashes, and clay, or chalk; there should be a good window on one side, and a door in halves.

*Implement House.*—In the old method of carrying out agricultural operations, very few implements, and those but of little value. were used. Half-a-dozen clumsy wooden ploughs, two wooden rollers, with one or two sets of clumsy harrows,

constituted the entire stock. The roller spent nine months of its time exposed to all weathers, at the corner of the field where last used, or in a green lane adjoining the land. The harrow, if much cared for, was reared up under the dripping eaves of some building; and as for the ploughs, they never left the field.

This being the farmer's practice, it may be imagined no implement house was thought necessary, and in the old steadings none is ever to be found. To be sure, a small place was sometimes contrived, by carrying the eaves of some low building, generally the cart lodge, within a foot or two of the ground, into which hole a few things were occasionally crammed. No new steading can be considered complete, unless a properly constructed apartment be provided for all agricultural implements and tools, as the dead capital in implements, and cost of keeping them in repair, is now a very important item in farm accounts; and at every agricultural show may be observed new implements, of beautiful and scientific construction, for economizing and accelerating farm operations; and in nine cases out of ten, the effectiveness of these implements would be negatived if the working parts were neglected, and no encouragement is given to the implement maker to improve his machines by superior materials, if knowing it would be all thrown away by the rough usage they are afterwards subjected to.

The implement house should be large enough to contain all the implements of the farm; it should be thoroughly wind and water tight, and have a hard paved floor. The walls and ceiling would be the better for being plastered, and should be whitewashed once a year. Shelves should be provided for placing all the moveable parts of the implements, wood and iron tacks for hanging up others; a large closet, with a window in it, should be also provided, in which the foreman would keep all extra gearing, such as plough-shares, tines, ducks' feet, chaff knives, ropes, tackles, small tools,

and other articles. Over head a loft should be provided, for placing the ladders, poles, sheep troughs and cages, and other things requiring length in the berth.

In the "Royal Agricultural Society's Journal" will be found some judicious advice on the care of implements, by Mr. Crosskill, from which we extract the following. "When the ploughs are done with, let them be washed and put in their proper places; let the same be done with the drill, and so on with all the machines on the farm. The cost of this will be trifling, compared with the advantage. In order to effect it, select the most likely agricultural labourer upon the farm; put the implements under his care; make it a strict rule with all the men that such implements done with for the season shall be brought to one particular place, say near the pond or pump; the man having charge of the implements must then wash and clean them well before putting them into the shed, and at a convenient time, when not otherwise engaged, or in weather when out-door work cannot be performed, get them repaired and paint them. At the end of this shed, or implement house, there might be a lock-up workshop, with the door to open into the place, with a few tools, paint pots, &c., the expense of which would not exceed 5*l.* The man should be encouraged to make his duty a pleasure, and to feel a pride in showing his master's implements in fine order."

*Cart Lodge.*—Any ordinary cheaply constructed shed will suffice for sheltering carts, &c. It may be a lean-to against some other building; but it should always be enclosed on three sides, and be dry and thoroughly water tight. If doors are added it will be all the better.

*Drainage.*—This is a most important point to be attended to, and one of those generally neglected. The eaves of buildings in and about the steading must be provided with gutters and spouts which empty themselves into drains, so as to

carry off, clear of all yards and courts, every drop of rain water that falls from the immense surface of roofing that must necessarily exist in all farm steadings. The drains must be so arranged that none of the rain water can get into the liquid manure tanks, as, from the neglect of this precaution, a great deal of money is wasted by farmers in carrying to their land discoloured rain water under the impression that it is liquid manure.

Of the various kinds of gutters used for farm buildings, I am inclined to give the preference to the plan of making the last eaves-tile of the gutter thus:—

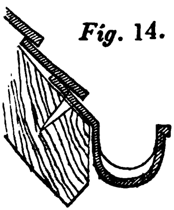


*Fig.* 14.

This plan was exhibited in different sorts of tiles and slates at the Great Exhibition, with a continual stream of water constantly running over the roof, and away by the gutter so formed. It appeared to answer well; the difficulty would, of course, be in keeping the joints water tight, and arranging for the fall, when the building is of great length. This is done by making the tiles thicker at one end than the other. There are such a variety of cheap gutters made now of zinc, iron, and other materials, that the expense cannot for a moment interfere with the advantage to be gained. Stack pipes must be placed in proper situations to carry off the water to the proper receptacle.

*Drinking Ponds* for the stock, should be placed in a convenient situation, and be a properly formed work. The shape of the pond is by some preferred circular; but, I think, if it has a well-formed bottom of hard stones, and side walls of brick or masonry, a parallelogram will be the best shape, deepening towards the centre—the extreme depth should not be more than to cover the horses' knees. Horses on no account should be allowed to wet their bellies, although the men are very fond of splashing them about in deep water, the

true cause of which is to save their own labour in cleaning the animal. A considerable thickness of good clay should be laid under the pond, and as a backing to the side walls.

A good tank should be placed at such a height as to supply the drinking-troughs in different parts of the steading.

It is of the first importance that the ground about, as well as that upon which the steading stands, be thoroughly dry. This is best effected by its being well tile-drained at a considerable depth; a line of ordinary field pipe tiles should also be laid by the side of the footrigs of all foundations around the whole of the buildings, the expense of which is very trifling, compared with the advantages of the dryness that will follow.

## FARMER'S RESIDENCE.

In discussing the question of farmers' residences, it will be necessary to consider the dwelling as one strictly suitable to a person who gets his living from the cultivation of the soil, and proportioned to the size of the holding, the capital employed, and the position in society that he has a right to assume, from the possession and application of that capital.

I hear it very commonly remarked now, by persons who do not know much about the matter (and, therefore, do not sympathize with the farmer in his present position), that he is much too well lodged, and that, instead of a farm-house, he occupies a mansion. The simple style of his forefathers is abandoned, and the old-fashioned house place is not now good enough; but elegant drawing-rooms, boudoirs, and conservatories, are necessary to the comfort of the farmer and his family. They also complain that he keeps his hunter and a couple of dogs, and has a double-barrelled gun, *not made at Birmingham*.

These remarks can only be made by persons who are entirely ignorant of the amount of capital necessary to carry on the agricultural operations of rearing and feeding stock, and

the cultivation of the soil, in a proper and efficient manner. A person carrying on any ordinary business in town or city, employing the same amount of capital, would live in precisely the same manner, and occupy a station in society in proportion to his character and wealth, exactly as is done by the agriculturist in the country. It is, therefore, necessary, in considering the size and accommodation of his dwelling, to proportion it strictly to the amount of land occupied, it being presumed that the proper amount of capital per acre is embarked in it, and that *the agriculturist and his family have the same right to the luxuries and refinements of life as another person who has embarked the same amount of capital in spinning cotton, or printing calico.*

The construction of the farmer's residence, therefore, becomes a matter for him and the architect to consider and arrange between them, according to their own fancy; and not being in any way connected with the working part of the steading (except in very small farms, such as plate 15), I do not think it necessary, in a book of this limited size, to enter at all into its construction, as, in modern steadings, it is well removed from the yards and sheds, and is not necessarily near them. That I am right in this view of the case is proved, I think, by the designs, sent to the Royal Agricultural Society, not having any residences attached, except for the herdsman and housekeeper.

*Kilns.*—Kilns used in connexion with agriculture are of various kinds—for burning, as for lime, tiles, and bricks, and for drying, as for hops, and oats, and for malting barley.

Lime is the protoxide of calcium, formerly thought to be a simple substance, but now ascertained to be a compound of oxygen and a metallic base. It is powerfully caustic, and has properties intermediate between those of an earth and an alkali. It is found in combination with a variety of

of acids—with sulphuric acid in gypsum, and with carbonic acid in silicious, magnesian, and common limestone. In chalk and marl, and in some of their combinations, it becomes an important constituent of the earth's crust. It does not naturally occur in an uncombined state, and whenever it is wanted by itself it must be separated from some one of its natural compounds; and for agricultural purposes, this is generally done by calcination in a kiln.

These kilns are constructed in a variety of ways according to the extent of the work to be carried on, and the manner of burning.

The simplest, and that generally used by agriculturists, is a draw kiln, constructed in the side of a hill, to avoid as much as possible the expense of brickwork or masonry. An excavation is made in the shape of an inverted cone (or formed in the solid brickwork), and lined with fire-brick, or the best kind the locality produces. These kilns may be made of any size—an ordinary one is about ten feet diameter at the top, and tapering down to about six at the draught-hole, as in *fig.* 15.

SECTION OF DRAW KILN.

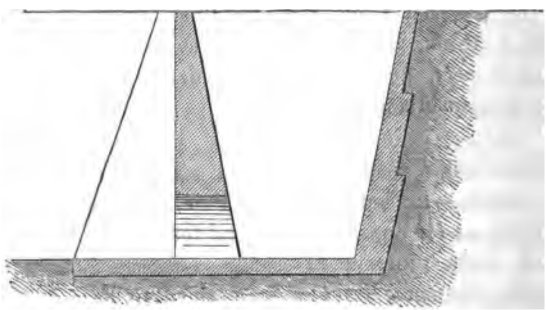


*Fig.* 15.

The depth for that diameter should be not less than ten feet. Two iron bearing bars are laid across to support the

fire-bars, which are placed about an inch apart, and should be about an inch and a quarter square, with length for sufficient bearing into the solid brickwork. When the kiln is first started a large fire is made upon these bars, and upon it pieces of limestone are placed; and when they are well heated another layer of coals is added, and then more chalk, and so on to the top of the kiln—the quantity of fuel being regulated by the kind of material to be burnt, and which is soon found in practice. The kiln being kept properly alive will continue burning for any length of time without rekindling, the limestone and fuel being supplied at top as it is removed from the eye.

It is usual to draw once in twenty-four hours, which is done by removing the fire-bars, and drawing as much lime through the eye as the experienced lime burner knows to be thoroughly calcined. The bars are then replaced as before.

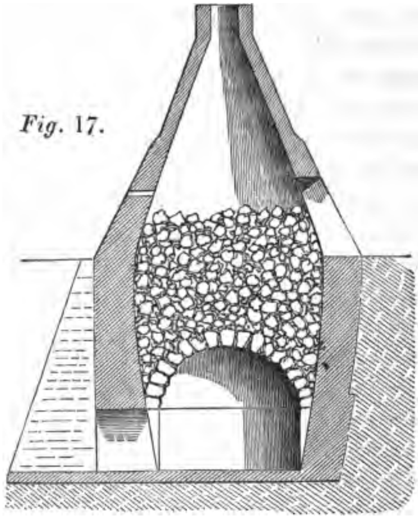
There are a great variety of kilns made upon this principle, but varied according to the amount of business to be done, and the material to be converted into lime. When very large they have two or three eyes to the kiln, and a vaulted passage is made round the back of it to allow of the lime being drawn.

In those counties where copse-wood, furze, or fir bavins are plentiful, they are used as fuel for burning lime, tiles, &c., and when this is the case, a different arrangement is adopted, called a flare kiln.

In this plan all the kilns have a regular head or roof, and the firing takes place at the bottom, and is continued till the whole kiln of limestone is calcined. The fire is then suffered to go out, and the lime is removed; a new quantity of stone is placed in the kiln, and the firing again takes place.

*Fig.* 17 is a section of a flare kiln, such as are in common use in North Hants, and in Surrey, in the neighbourhood of Farnham, where most extensive manufactures of red pottery are carried on, which, as well as lime and bricks, are burnt in this manner.

SECTION OF FLARE KILN.




In preparing a kiln of this kind for firing, it is necessary to construct an arch of the materials to be burnt; of bricks, if for bricks, and of the large blocks of chalk or stone, if for lime. To facilitate the construction of this arch, a bench is built all round the kiln about four feet from the floor from which the arch springs. In small kilns for lime, only one arch is turned, but in large ones a pier is constructed through the centre, and a double arch is built. The largest and best-shaped lumps being selected for the purpose, on the top of these are placed the smaller pieces, as in *Fig.* 17.

The fuel is placed under the arches, and a large body of flame kept up, which finds its way through the interstices of the lime. The flame is increased towards the end of the burning; and at last the driest and best fuel is added, and the whole mass raised to a white heat, by which the whole of the carbonic acid is expelled, and the chalk or other material converted into lime.

# CHAPTER IV.

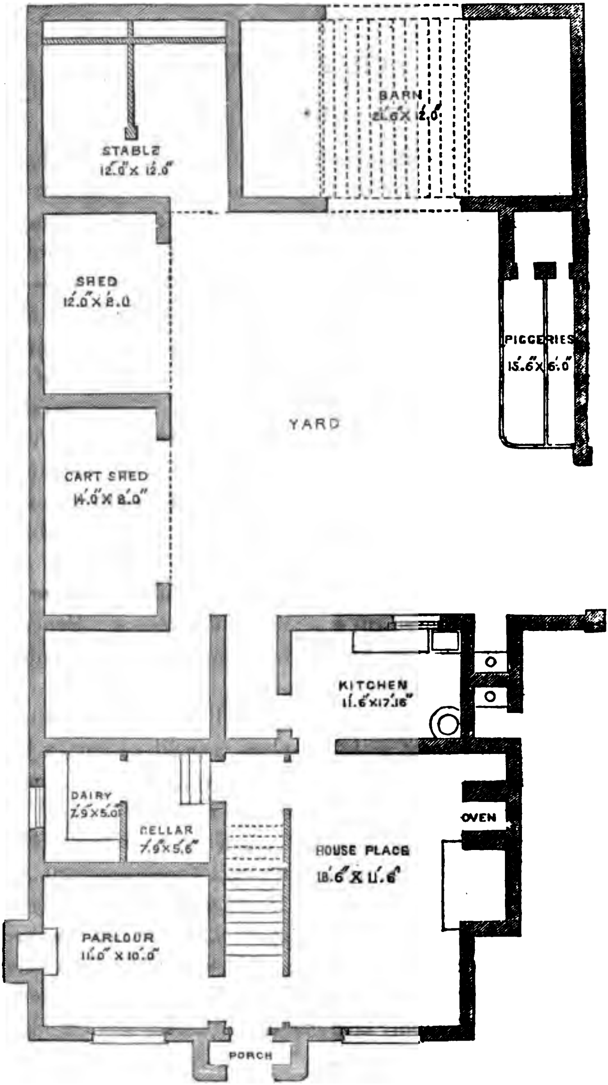
## SMALL FARMS.

The smallest size steading that can be required is that of a farm of about forty or fifty acres (that is, one that will employ one pair of horses). There are a great many of these to be found in England, and generally they are exceedingly well managed, as the farmer himself does the principal part of the work, and takes a part in everything. These little farmers are sadly in need of assistance; for the accommodation for themselves and their stock is of the poorest possible description, the farm-house being generally a larger description of cottage, and the agricultural buildings only one or two sheds. Not having the advantage of valuable implements for economizing labour, it is especially necessary that he should have all the advantages of convenient buildings. I never remember to have seen one of these little yeoman farmers who had a tank for his liquid manure, or the least modern improvement applied to his dwelling. Generally too humble to ask it of his landlord, and of too little importance to be thought of without.

The accommodation consists of dwelling-house, containing a general living room or house place, a small parlour, a back kitchen, adapted for a scullery, brewery, &c., and a small dairy and cellar. Above are three bed rooms.

The farm buildings consist of a cow byre for two or three cows, a stable for two horses, a small threshing barn with threshing floor and two bays, a piggery for breeding-sow and fatting hogs, a shed for cart, fuel, and other purposes, a straw yard with liquid-manure tank, with drain from privy, cow byre, stables, house, &c. The whole is designed to economize labour, and supply comfort to the tenant and his family at the smallest possible cost.

PLATE 15.




GROUND PLAN OF SMALL STEADING.

*Fig.* 18.

ELEVATION.

## ESTIMATE FOR SMALL STEADING,

*Consisting of Dwelling-house of Six Rooms, Barn, Stable, Cow Byre, Piggeries, Manure Tank, and Drains to ditto.*

| | £ | s. | d. |
|---|---|---|---|
| 25 yards cube of excavation . . . . . . | — | — | — |
| 7½ rods of reduced brickwork . . . . | — | — | — |
| 63 yards superficial of brick flat paving . . . | — | — | — |
| 16¾ squares of Countess slating . . . . | — | — | — |
| 166 yards superficial of render set to walls of house . . | — | — | — |
| 90 yards superficial of lath, plaster, and set ceilings . | — | — | — |
| 330 feet cube fir joists, rafters, wall plate, &c. . . . | — | — | — |
| 29 ft. 6 in. cube wrought, and rebated door and window frames . . . . . . | — | — | — |
| 113 feet cube fir framing to barn . . . . | — | — | — |
| 13 ft. 9 in. cube oak wrought posts and sills . . . | — | — | — |
| 1 square superficial oak threshing floor to barn . . | — | — | — |
| 5 square superficial inch folding floor in dwelling-house . . | — | — | — |
| 17 square superficial slate battens . . . | — | — | — |
| 4½ square superficial ¾ weather boarding to barn . . | — | — | — |
| 40 feet superficial 1½-inch wrought and rebated jamb linings, | — | — | — |
| 35 feet superficial 1½-inch wrought partition to stalls . | — | — | — |
| 142 ft. 6 in. superficial inch proper ledged doors . . | — | — | — |
| 230 feet superficial 1½-inch braced doors to barn . . | — | — | — |

Carried forward

| | £ | s. | d. |
|---|---|---|---|
| Brought forward | | | |
| 32 feet superficial inch ledged shutters . . . | — | — | — |
| 73 ft. 6 in. superficial inch treads and rises to stairs . | — | — | — |
| 50 feet superficial inch cupboard front, with 4-panel door to ditto, complete . . . . . . | — | — | — |
| 28 feet superficial inch wrought top and shelves to do. . | — | — | — |
| 15 feet superficial inch wrought seat and riser to privies, | — | — | — |
| 30 feet superficial ½-inch wrought window linings . | — | — | — |
| 122 feet superficial ¾ square skirting . . . . | — | — | — |
| 12 feet run 1½-inch manger and oak curb . . | — | — | — |
| 11 ft. 3 in. superficial inch chimney shelf . . . | — | — | — |
| 6 feet superficial 2-inch chimney shelf . . . | — | — | — |
| 5 feet run handrail with newel bar and ballusters . . | — | — | — |
| 39 feet superficial hearth and back hearths . . . | — | | — |
| 38 ft. 10 in. superficial 1¾ mantle and jambs. . . . | — | — | — |
| 4 ft. 10 in. cube stone sills to doors and windows . . | — | — | — |
| 10 feet cube stone plinths . . . . . | — | — | — |
| 10 ft. 6 in. superficial 2½-inch York step. . . . | — | — | — |
| 4 feet superficial York stone sink . . . . . | — | — | — |
| 118 yards superficial painting in 3 oils . . . | — | — | — |
| 40 yards superficial painting in 4 oils . . . | — | — | — |
| 28 feet superficial iron casements glazed . . . | — | — | — |
| 2 cwt. of wrought ironwork, for general purposes . . | — | — | — |
| 65 feet run of 3-inch cast-iron guttering . . . | — | — | — |
| 24 feet run of 2-inch rain water pipe . . . . | — | — | — |
| 2 heads, at 1*s*. 10*d*., 2 shoes . . . . . | — | — | — |
| 30 wrought iron brackets and nails to ditto . . . | — | — | — |
| No. 10 pair of 18-inch × garnet hinges, at 1*s*. 2*d*., 9 Norfolk thumb-latches, at 7*d*., 4 9-inch barrel bolts, at 9*d*., 4 6-inch iron rimmed locks, at 2*s*. 6*d*., 4 wrought-iron bars to windows . . . . . . | — | — | — |
| 4 pair of strong hooks and bands to stable and cowhouse, at 2*s*., and 2 pairs of ditto to yard gates . . . | — | — | — |
| No. 1 2-inch cast-iron pump fixed to tank . . | — | — | — |
| 5 feet of 1½-inch lead supply pipe to ditto . . . | — | — | — |
| 5 feet of 2-inch lead waste pipe to sink . . | — | — | — |
| | £207 | 0 | 11¾ |

Total cost of building, fitting, and finishing ready for occupation, exclusive of builder's profit of the above, amounts to 207*l.* 0*s.* 11¾*d.*

*Farm Labourers' Cottages.*—Scarcely any subject has had more attention bestowed upon it (by all sorts of persons, architects, landscape gardeners, philanthropic individuals, and others) than the social condition of labourers, and the external appearance and internal accommodation of their cottages. Nine-tenths of the books, both illustration and letter-press, are utterly useless for any practical purpose. The larger works are all devoted to designs of a strictly ornamental character for model cottages for labourers, bailiff, &c., and of every conceivable design, imported from every country of every climate in the world; these are chiefly meant to add beauty to the landscape immediately adjoining some nobleman's mansion: they were thought very fine in their day; but the true Christian principle of constructing a house adapted to an English climate being now properly understood, these absurdities merely exhibit their handsomely bound backs in the library, or lie as heavy weights on the shelves of the bookseller's shop. Labourers' cottages, such as the practical farmer has to do with, must be looked at as positively necessary to an estate, and of an useful character, so that we must consider what accommodation labourers can do with comfortably, and what he can afford to pay, and give him the most we possibly can for his money.

The rent of agricultural labourers' cottages varies in different places from one shilling per week, upwards, with a small garden only. Half-a-crown per week is as much as labourers can be expected to pay for a comfortable cottage and small garden, and this should consist of a house place, back wash-house, and two bedrooms over. An oven and copper should be provided, with a privy and hog-stye; for though I do not think much of what cottagers gain by their

hogs, yet I think it is a sort of savings-bank, where something is being constantly put by that would be wasted or spent at the nearest beer-house.* It is quite certain that the designs for labourers' cottages usually made by architects, cannot possibly pay any fair interest for the outlay. It is clear, then, that as the labourer can only afford at most five pounds per annum, and that he must have the accommodation we have described to live decently, every means must be tried to lessen the cost of constructing his dwelling; and the principal points to be kept in view are, to avoid all breaks in the walls as much as possible, and to make everything work square, in order to get the whole under one roof without breaks. It is a common practice with the modern architect to design cottages with immense projecting eaves, to have the roofs lapping over one another, which must be the case if lean-tos and smaller gables are placed against the walls, and a large one over. This is roofing the same area twice over, and, of course, is an unnecessary expense. The roof should have no more pitch given to it than is necessary to carry off the water and the snow properly. The plan adopted now of constructing roofs of an enormous height is bad; in fact, some architects make the whole cottage out of a roof, bringing the eaves of some parts down to within a few inches of the ground, and this they conceive to be the picturesque early English style, of which it is, in reality, only a caricature.

Doubtless, cottages and other buildings constructed upon the plan of the early English architects, will last longer than any other, and be the most comfortable to live in, and the most pleasing to look at.

I perfectly agree that it is so, but they are by far the most costly; and I must say, as I have before said, that with wheat at 36*s*. they are not to be thought of by those whose

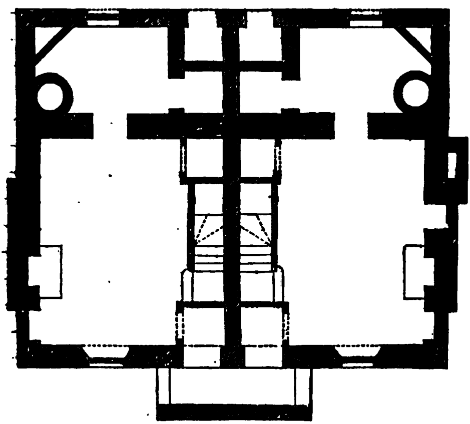
* Some farmers object to their labourers keeping hogs, and instead supply them from their own styes with a fat hog at the price it stands on their books, the labourers paying a small sum weekly for it.

necessities require them to receive a small per-centage on their outlay even for housing their labourers.

The annexed design is for a double cottage for ordinary farm labourers, and estimated to be erected and finished ready for habitation, for 95*l.* each cottage :—

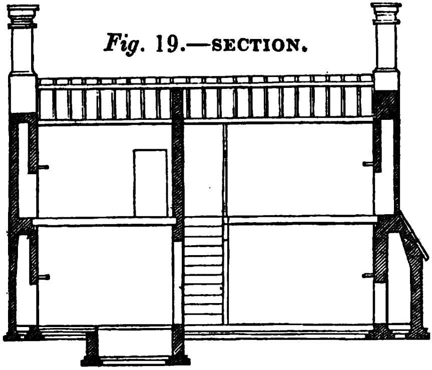
PLATE 16.

ELEVATION.



PLAN.

Fig. 19.—SECTION.



*Cost of Building a Farm Labourer's double Cottage.*

| | £ | s. | d. |
|---|---|---|---|
| 20 yards cube of excavation to foundation | — | — | — |
| 8 rods superficial of reduced brickwork | — | — | — |
| 16¾ square superficial of Countess slating | — | — | — |
| 200 ft. cube of fir joists, rafters, plates, &c. | — | — | — |
| 27 ft. 6 in. cube of fir wrought door and window frames | — | — | — |
| 4¾ square superficial of inch folding floor | — | — | — |
| 16¾ square superficial of ¾-slate battens | — | — | — |
| 280 ft. superficial of 1½-inch framed partitions | — | — | — |
| 336 ft. superficial of inch proper ledged doors | — | — | — |
| 112 ft. superficial of 1½-framed and ledged doors | — | — | — |
| 32 ft. superficial of inch seat and riser | — | — | — |
| 126 ft. superficial of inch square skirting | — | — | — |
| 24 ft. superficial of 1¼ jamb linings | — | — | — |
| 46 ft. superficial of ½-inch window linings | — | — | — |
| 27 ft. superficial of inch chimney shelf | — | — | — |
| 28 ft. superficial of inch shelves | — | — | — |
| 54 ft. superficial of inch treads and rises to stairs | — | — | — |
| 36 ft. superficial of 2½-inch York step | — | — | — |
| 37 ft. 6 in. superficial of 1½-hearths and back hearths, | — | — | — |
| 8 ft. superficial of York sink | — | — | — |
| 26 ft. 3 in. superficial of ½-inch mantle and jambs | — | — | — |
| 32 ft. run of York window sill | — | — | — |
| 85 yards superficial of brick flat paving | — | — | — |
| 287 yards superficial of lath plaster, and set | — | — | — |

Carried forward

| | £ | s. | d. |
|---|---|---|---|
| 290 yards superficial of render set . . . | — | — | — |
| 100 ft. run of compo labels outside . . . . | — | — | — |
| Cesspool to privies . . . . . | — | — | — |
| Rain-water tank, 300 gallons . . . . | — | — | — |
| 1 2-inch cast-iron pump . . . . . | — | — | — |
| 5 ft. run of 1½-inch lead pipe . . . . . | — | — | — |
| 5 ft. run of 2-inch waste to sink . . . . | — | — | — |
| 230 yards superficial painting in 3 oils . . . | — | — | — |
| No. 2 heads, 6*d.*; 2 shoes, 6*d.* . . . . | — | — | — |
| 75 ft. run of 3-inch cast-iron eaves gutter . . . | — | — | — |
| 26 ft. run of 2-inch rain-water pipe . . . | — | — | — |
| No. 2 heads, 1*s.* 10*d.*; 2 shoes, 1*s.* . . . . | — | — | — |
| No. 30 brackets and nails . . . . | — | — | — |
| Labour fixing ditto . . . . . . . | — | — | — |
| No. 22 Norfolk thumb latches, 7*d.*; 4 7-inch iron-rimmed locks, 2*s.* 6*d.*; 22 pair of 18-inch X garnett hinges, 1*s.* 2*d.*; 4 9-inch barrel bolts, 9*d.* . . . . . | — | — | — |
| 80 ft. superficial cast-iron casements glazed . . . | — | — | — |
| Exclusive of Builder's profit . . | £189 | 0 | 0 |

## SPARRED FLOORS.

*Sparred Floors for Cattle Sheds* are among the more modern improvements introduced in the construction of farm steadings; it is having the joists of the floor of the feeding houses covered with spars or laths, instead of boards. Mr. Huxtable, of Sutton Walden, has the credit of having introduced this plan, but it is by no means new, having been used in Gloucestershire for many years, for flooring the calf pens and feeding sheds, as the following extract from a survey of Gloucestershire will prove:—

"It is observed by Marshall, that all the calf pens in Gloucestershire are of a durable construction, extremely simple, but singularly well adapted to the object. The house or rooms each measure 12 feet by 8: 4 feet of its width are occupied by the stage, and 1 foot by a trough, placed on its front, leaving three feet as a gangway, into the middle of

*G

which the door opens. The floor of the stage is formed of laths about 2 inches square, lying the longway of the stage, and 1 inch asunder; the height of the floor of the stage from the floor of the room is about 2 feet."

I cannot do better in describing this method of flooring, than by quoting Mr. Mechi's own description from a paper read by him to the Society of Arts Nov. 27, 1850, on British Agriculture. He says:—"Having practised the system rather extensively, I will communicate to you the details; observing, that although attended, as every system must be, with certain disadvantages, the balance of benefit is sufficiently considerable to induce me to continue and extend it. The quantity of stock I have now on boards is 100 lambs, 60 calves, 10 cows, 50 sheep, 30 bullocks, 200 pigs. We are indebted to the worthy and Rev. A. Huxtable for the idea; but I found a space of ¾ of an inch between the planks insufficient; I therefore measured the hoofs of the various animals, and arranged my openings accordingly. Thus,

| | Inches thick. | Do. wide. | Do. space. |
|---|---|---|---|
| For Bullocks . . . | 3 | 4 | 1⅞ |
| For Sheep . . . | 1½ | 3 | 1¼ |
| For Pigs . . . | 1½ | 3 | 1¼ |
| For small Pigs and Lambs . | 1½ | 3 | 1 |
| For Calves . . . | 2 | 3 | 1⅝ |

For large Cotswold or Kent sheep, 1⅜ opening would not be too large; 1¼ openings do well for Hampshire Down lambs, but are rather too large for small Sussex Downs.

"One cannot too highly appreciate the system on heavy lands where the animals cannot be profitably folded during winter. The area allowed for each animal, and its feeding apparatus, is thus:—

| | Sup. feet. | | Sup. feet. |
|---|---|---|---|
| Small sheep . . | 8 | Small bullocks . | 30 to 40 |
| Large sheep . . | 10 | Large bullocks . | 50 to 60 |
| Small pigs . . | 6 to 8 | Large pigs . . | 9 to 11 |

"Very much depends on the season and weather. In cold weather pigs and bullocks can scarcely be packed too close, so long as there is room for them to lie down comfortably. Sheep require a little more room, or ventilation. In fact, it requires a nice observation to adjust the ventilation and temperature. This is best done by a thermometer, because our own feelings are not always a sufficient criterion. Every cattle shed should feel as comfortably warm as a drawing-room. The opening for ventilation should be at the highest point. I should say that the bars or planks may be either of straight-grained yellow deal, or straight-grained hard woods: the latter are to be preferred for heavy animals, as they wear off the edges of the deals. The depth of the pits may be from two to four feet. It is necessary, once in a way, to level the manure to prevent it touching the boards: it would soften them, and cause them to break. I should say that we never sweep the floor, but the animals are perfectly clean. Of course the manure is taken at once from under the boards to the fields, without the interventional expense of a double carting, shooting, or turning over a dung heap. The effect on the crops is unmistakable.

"In order to pay you 10 per cent. on your investment for the whole building and floor complete with troughing, &c., you would charge your bullocks 1½*d.* per week; sheep and pigs, ¼*d.* per week. The cost of erecting covered homestalls complete, with boarded floors, will not exceed 1*s.* to 1*s.* 3*d.* per superficial foot.

"One man on my farm feeds, and entirely attends to, 250 pigs. It would require two men on the old straw-bed system. Our pigs are never cramped now; formerly they used to be, owing to the manure heating under them, and the cold air giving those parts rheumatism. I must confess that I never like the look of my animals so well on them, as I do on a little mountain of clean straw, or a nice green pasture; but this is not a question of fancy, but profit, and I am quite sure

the system is quite advantageous. It is true we like a soft bed, and so do the animals, but our medical advisers recommend a hard one.

"There is a very powerful development of the muscles on boards, so much so that with fattening pigs not bred on the boards, I have found some of them get capped hocks. It is surprising how quickly you may fatten *young* pigs on these floors. They find it inconvenient to run about, and so divide their time between eating and sleeping, a most agreeable operation for the account book.

"Another question connected with the boarded system, is the fly question. Where you have plenty of food, warmth, and stock, you will have abundance of flies. My bullocks could never lie down in the day time, owing to their attacks, and of course the continued lifting of their feet prevented fattening. By darkening the feeding houses, I entirely removed this nuisance, and had the gratification of putting my animals into a most profitable state of repose; for if you have ten millions of flies, not one will bite in the dark. I find that some of my friends, who value the condition of their horses, have long practised this system. It is essential to the successful house feeding of bullocks with green crops during summer. Sheep are never struck by the fly on boards, and do not seem to be much annoyed by them."

Now I have myself seen cattle houses floored in this way, several times, both at Mr. Mechi's farm and elsewhere, and cannot say that I was at all impressed in its favour by appearances. The cattle looked extremely uncomfortable, especially when, as I once saw them at Mr. Mechi's, the floor was also strewed over with lumps of burnt clay. I have consulted several farmers of great skill and sound judgment as to the merits of this plan, and generally found an opinion expressed *unfavorable to it.*

Objections to it have been well and humanely urged by the Rev. George Wilkins in a letter to the *Agricultural Gazette*

of December 4, 1847. The reverend gentleman, in speaking of a plan somewhat analogous to Mr. Mechi's, only less finished, says, "The excrements of all kinds of animals are made offensive to them by an obviously wise protection. In building cattle sheds, therefore, I would earnestly impress upon the attention . . . . . above all things to have regard to perfect sweetness and cleanliness." Again, Mr. Wilkins says, "I lately inspected one of these sheep sheds" (an open boarded or sparred floored one). "Although the weather was fine the wool of the poor animals was wet and dirty from the urine and dung sticking on the boards on which they lay, and when I entered the dirty slippery place, a smell from the gases, by the active fermentation of the dung and urine in the pit below arose offensively, and made me quickly seek an exit."

It is somewhat surprising that Mr. Mechi, whose remarks on the advantages of supplying cattle with pure and clean water are so judicious, does not see that if it is a bad thing to adulterate water which cattle drink occasionally, with the manure which is suffered by careless farmers to drain into it, it must evidently be as bad, if not worse, to allow that air which they breathe every moment of their lives to be contaminated by gases equally the products of the same manure, and which must inevitably pass into the lungs of the unlucky animals. In differing thus from Mr. Mechi, I am aware of the weight due to his opinion, and must be understood here only to state my own personal views on the subject; any one who sees the plan can judge for himself. It has, no doubt, advantages, where straw is of great value and litter scarce.

## CHAPTER V.

### BUILDING MATERIALS.

The stone used in the construction of farm steadings, need not be of the costly character required for the generality of large houses. Quoins excepted, the walls of all buildings may be constructed of rubble masonry; that is, masonry

reduced to something of a square shape, or irregular course, but not fixed to any positive rule, or to thickness. A most excellent description of this kind of rubble building is used in Yorkshire and the Midland counties, called snicked rubble, which is a square masonry composed of all sizes, without reference to any horizontal line in the wall course. Where stone can be obtained at a cheap rate, like the ragged flint, then the only rule to be observed is to break a face in the flint or rag stone, and lay all the pieces in the most advantageous position to form as solid a wall as possible, and keeping the face as true as the nature of the material will admit of, filling all the interstices with mortar made from hydraulic lime, and the sand to be used therein to be of a mixed quality, containing large and small grains, sharp and clean. Such walls carefully constructed, are amongst the most durable of all buildings hitherto erected.

I have myself constructed some agricultural buildings with large unfaced flints, and when the lime is good it is most excellent work. The irregular shape of the flint makes capital bond; and I found a short time after, in cutting through these walls to put up some machinery, that the flint could not be removed, but had to be faced to make fair work.

I believe that most excellent walls for agricultural purposes may be made with small irregular-shaped stones, whenever they can be got, if the lime is good. The quoins must be of brick. The cost of the work I found to be about 7*l.* per rod; the brickwork, at the same time, costing 12*l.*

In selecting stone for farm buildings, durability in resisting weather is of more consequence than size; and to ensure this, it is very important that a stone be selected of great purity in the grit, and freedom from aluminous combination, for it must be observed, that stone decomposes from two causes: first, from the material which combines the particles of grit being of a soluble character, though in an imperceptible degree; and, secondly, from the particles of grit being cemented

by alumina combined with lime, which combination is certain to decompose in a very short time, and is the cause why many good-looking stones burst after a short exposure to the weather immediately after their extraction. Such hard limestones as are combined with alumina are very liable to fall to pieces on exposure to the weather, and are altogether very deceptive as to their quality; sometimes even capable of taking a polish, and yet dropping to pieces after exposure to the weather of only one season.

If rough flag-stones can be obtained at a cheap rate, it is an excellent method of proceeding to lay a foundation of them before the rubble walling is commenced, and also at intervals to use them as thorough or bond courses.

*Bricks.*—Perhaps in no description of buildings are hard, durable bricks more required than in those devoted to agricultural uses; and in no description is the quality of bricks less attended to. If the brick be hard, and if cement be used, then many walls may be constructed in a most durable manner by joining the bricks with the cement: it has been too much the custom, however, to look at the shape of the brick in preference to the quality of hardness; but the rule ought to be to look to the perfect vitrification of the brick throughout as the first requisite to quality, and then look to shape as the second condition; but if all things are properly attended to in the manufacture of these articles, there is now no reason why both these qualities should not be united in the same brick, since the excise duties on bricks have been repealed, and freedom of action is allowed as to their size. Before commencing the building of a steading, an investigation of the soil of the farm in question should take place, and the facts be ascertained as to the quality of the soil for making on the spot; and even if it be no cheaper to make the bricks on the farm, still if a careful brickmaker is selected, the quality of the article will make full compensation for all the trouble

bestowed on the manufacture: besides, coping bricks, large drain tiles, hollow bricks, paving tiles, slabs for various purposes, beveled bricks for drains, and circular tanks, can all be made at the same time, by using a little extra care in selecting and testing the clay, and using a due degree of patience in ascertaining how much of different varieties of clay (often found in the same pit) will make the best mixture.

*Burned Ballast.*—An article called burned ballast, has now come into very general use for making the foundation of roads. This material may be employed with great advantage in the construction of farmeries, for laying dry the roads and yards, and for filling in foundations to buildings, if mixed with hydraulic lime. If clay is in the vicinity of the building intended to be erected, and coals are cheap, then a brickmaker will easily produce the necessary supply by merely casting the clay in heaps, and mixing the clay with a due quantity of coals. The manner of proceeding being to make a small heap of coal, and surrounding it with clay; after the coal is ignited, then strew over a small quantity of coal, and when that is ignited a further quantity of clay; and so on until the heap is somewhat large: then proceed by using barrows and planks to put the clay and coal upon the top of the heap, and when it is ignited, then rake it down to the foot of the heap and cover it again with more clay—the great point to observe being that of always maintaining a perfect combustion in the mass, and, at the same time, enclosing the fire within in all its intensity: and to ensure this, it will be needful from time to time to insert rods into the interior to let in the air. Simple as the operation may seem to burn ballast, it will require incessant attention, otherwise it will be under-burned.

Many think when a heap of clay is burned through and looks loose and bricky, it is sufficiently done; but this is a mistake, the ballast requires to be as hard as the best burned

bricks, in which case it will be very much concreted into blocks—these may be easily broken into the requisite sizes. When coals are not very dear, ballast may be burned for two shillings per cubic yard; the hard blocks will answer for underground work in foundations, as well as bricks.

*Timber.*—Although farms often produce more timber than is beneficial for the farmer's interest, yet with few exceptions it will be better to obtain Baltic timber than use that found on the farm. If cills, foundation plates, steps, and some few other parts of buildings, be made of oak, all the rest may be constructed from such fir timber as is well filled with its own natural gum resin.

In a former part of this work, we have insisted on the advantage of saving the interest of the capital, by constructing buildings of less cost, although they may require more frequent renewals. This maxim cannot be carried out better than by constructing buildings for farmeries of timber; and to do this in the most effectual and durable manner, it will be desirable to construct all foundations (where manure is liable to be lain, or as high as drips and damps may affect the structure) of solid brick, upon which the timber framing is to be built.

The old fashioned weather-boards which overlap each other are the best of all forms for durability. Some other shapes have been adopted to look more like stone, but the wet is liable to get into the joints and cause an early decay; there are abundant examples of the old weather boarding lasting from sixty to a hundred years, having been periodically painted. When it is stated that timber buildings will be cheaper than any other description of building, exception must be made to some inland districts where bricks are very cheap and sea-borne timber is scarce; in such cases it may be as economical to build with bricks as timber, but such cases are rare—and

such places as where stone is extracted on the farm at but little cost; it will, nevertheless, often now be cheaper to build with brick than use such stone.

*Lime and Cement.*—But little care is ever exercised in selecting the proper materials for making lime, nearness and convenience generally deciding the question as to the description of the lime to be used: from its being one of the materials required for ameliorating the condition of the land, it might be thought that a greater knowledge would exist as to the good and bad lime, but information brought into requisition on this head has been of a very limited kind; however, the following short rules will be found useful in judging the sort of lime which should be admitted into the work. Lime which slacks with great rapidity, and immediately falls into fine flour and sets quickly, is not good for building purposes, and but seldom for agricultural purposes; in the latter case, for its caustic quality in destroying moss and vegetable matter; yet this is the sort of lime used in most cases for constructing farm buildings. The rule to be observed in choosing limestone is this:—burn some of it, and then quench it with water, and if it slacks very slowly so as only to be just perceptibly burnt or break after half-an-hour has elapsed, then it may be considered a good hydraulic lime (that is, will set under water); such lime ought to be burned for so long a time that it will have a yellow or drab tinge when drawn from the kiln; if, on the other hand, it looks white and speckled, it is under-burnt, and will not make good mortar. Some good limes will not slack unless by exposure to the air, and only fall down after exposure for several weeks; such lime is called wind-slacked, and is the best of all limes for mortar making; if this description be well burned and then put where there is plenty of access to the air, and be turned over often so as to expose new surfaces to the weather, it will form the best mortar known;

such limes are generally extracted from the Lias formation, but other formations will offer the materials if due diligence be used in selecting them.

*Cement.*—Cement is a most useful material to be used in farm buildings, notwithstanding it has scarcely been introduced for that purpose; it will be found to be most advantageous to use this material in small buildings, instead of lime mortar, and thin the walls so much as will make them cost no more than an ordinary mortar wall, but great care is required in obtaining a *good strong* cement, quite fresh, and allowing the workmen to use only a small quantity at a time; if this requisite rule be not rigidly observed the cement will be inferior to mortar. Cheap cement is often not worth having, but if good and proper precautions be used, the joints so formed will be as strong as the bricks themselves. If hydraulic lime or cement be used the quantity of sand must be diminished in proportion to its cementicious power, for the stronger the adhesive properties of either mortar or cement become, the less sand they can carry. In joining bricks neat cement is the best, and if care be exercised, it is as cheap as cement and sand combined; in no case more than one of sand and one of cement ought to be used, and the lime should be so strong and binding that it ought not to require more than one and a half of sand to one of lime; although the lime generally used will carry as much as three of sand to one of lime.

*Thatched Roofs.*—Formerly two-thirds of the roofs of agricultural buildings in England were covered with a thatch of some description, and at the present time it is a favourite roof, and deservedly so, for it possesses some great advantages over other roofs, the prinipal one of which is that of maintaining an equal temperature throughout the year—the inclement cold of winter, and the excessive heat of summer, being both excluded in a greater degree by this material than by any

other in common use. Also that it can be renewed and repaired by the ordinary labourers of the farm, and that the materials are generally at hand.

The chief disadvantages are a little extra insurance (which however is amply compensated by the extra comfort it gives to the stock), and that it is a harbour for vermin.

There are various materials used in thatching; the most common in England being the straw of wheat and rye, the latter being the best. Fern is sometimes used, and is said to last well. Ling and heath are also made use of in places where they abound; and sometimes heath is used for the underlay, and rye straw for the top. Hoop chips for a thatch may also occasionally be met with; but the best, and most economical in the end, is a thatch of marsh reeds, so very common in Holland and those counties of England whose physical features resemble it, as parts of Norfolk and the adjacent counties.

As the process of thatching is pretty much the same in all materials, with regard to its principles, we shall confine ourselves here to describing the methods pursued in thatching with reeds, and those who would wish to know more on the subject would do well to consult the prize essays of the Highland Society, by Campbell and Collier, on thatching with fern and heath.

The reeds used in thatching are of two kinds; the common marsh reed (*arundo phragmites*), and the sea reed, or marrum grass (formerly known as *arundo arenaria*, but termed by modern botanists *ammophila arundinacea*). As the latter is not in such common use as the other, and is better known by its properties in binding together by its roots the loose soil on a sandy sea-board, whence it is sometimes called mat grass, we shall confine our remarks to the marsh reed, which grows wild in most marshy places in Great Britain, to a height of from five to six feet, and is in flower about July, August, or September. The outer coating of all plants of the reed tribe contains a very large proportion of silex, and their internal

fibres are arranged similarly to cords laid closely together, and for these reasons they are nearly indestructible by the weather, and of course the larger the reed, the thicker is its outer coat of silex, and the more durable it is. We therefore easily discern the cause of the superiority of reed to thick straw, and of that again to thin, and why they are both probably inferior to bamboo.

The cutting of the reed requires considerable care and attention. It is done in the winter, and is carried on until the spring starts the young plants. They are cut with a peculiar form of sickle, more bent than the usual one, and it is a great point to cut them below the water right down to the roots, as the reed is much superior in strength and durability below the water, and not nearly so brittle as above. A large number of boats are always seen employed in this operation during the season of cutting; they are then conveyed ashore and made into bundles or sheaves, and set to dry, and afterwards made into stacks.

A considerable number are grown on the Essex shore of the Thames. These, however, are not used for thatch, but by the builders of barges and other vessels in coating the timbers and planking with pitch and tar.

In Holland, an immense quantity of the reed is grown for thatching; it is much liked there, and the work is executed with great skill and care. All persons who have travelled much in Holland, must have observed the peculiarly neat and effective manner in which the large windmills, which are so thickly studded over that remarkable country, are covered with a thatch of this material; not only the head is covered, the weather boarding of the mill, from the stage upwards, is protected in the same manner. Farm-houses, barns, and agricultural buildings of all kinds, may be seen covered in the same manner, and it is considered that the thatch, if well done, will last fifty years without repair; and, if repaired at the end of that term, will last fifty more: and reed-thatched roofs are to

be found in Holland in a good state of preservation more than two centuries old.

In thatching with reed, the workman begins at the lower corner of the roof on his right hand, for instance, and keeps an irregular diagonal line or face until he reach the upper corner to his left, a narrow eavesboard being nailed across the feet of the spars, and some fleaking (which is a little of the longest and stoutest of the reed scattered irregularly across the naked spars) scattered on; the thatcher begins to "set his eaves" by laying a coat of reed eight or nine inches thick, with the heads resting upon the flanking, and the butts upon the eavesboard. He then lays on his sway (a rod rather thicker than a large withy), about six or eight inches from the lower points of the reeds, whilst his assistant on the inside runs a needle threaded with rope-yarn close to the spar; and in this case close to the upper edge of the eavesboard. The thatcher draws it through on one side of the sway, and enters it again on the contrary side, both of the sway end and the spar; the assistant draws it through, unthreads it, and with the two ends of the yarn makes a knot round the spar; thereby drawing the sway, and consequently the reed, right down to the roof; while the thatcher above, beating the sway, and pressing it down, assists in making the work the firmer. The assistant having made good the knot below, he proceeds with another length of thread to the next spar, and so on till the sway be bound down the whole length, namely, eight or ten feet. This being done, another stratum of reed is laid upon the first, so as to make the entire coat eighteen or twenty inches thick at the butts; and another sway laid along and bound down about twelve inches above the first. The eaves are adjusted and formed not square with the spars, but nearly horizontal; nor are they formed by cutting, but by driving them with a "legget," a tool made of a board eight or ten inches square, with a handle two feet long fixed upon the back of it obliquely, in the manner of the tool used by gardeners in

beating turf. The face of the legget is set with large-headed nails, to render it tough and make it lay hold of the butts of the reeds. Then another layer of reeds is laid on, and bound down by another sway, somewhat shorter than the last, and placed eighteen or twenty inches above it, and above this another and another, continuing to shorten the sways until they be brought off to nothing, and a triangular corner of thatching formed. After this, the sways are used their whole length, whatever it happens to be, until the workman arrives at the finishing corner. By proceeding in this irregular manner, seams between the courses are prevented, and unnecessary shifting of ladders avoided.

The face of the roof is formed and adjusted like the eaves, by driving the reed with the legget; which operation, if performed by a good workman, not only gives the roof a beautiful polished surface, but at the same time fastens the reed, which being thickest towards the butts, becomes like a tapering pin, the tighter the farther it is driven.

Finishing the ridge of the roof.—In the case of reed running from four to six or eight feet long, the heads meet at the ridge of the roof, whilst the butts are still at a distance from each other. For this reason, as well as for that of the wear being less towards the ridge, the shortest (which is generally the worst) need be saved for the upper part of the roof. But even supposing the uppermost courses to be only four feet long, and that the heads (belonging to the two sides) be interwoven in some degree with each other, the butts will still remain six or seven feet asunder, and the ridge of the roof consequently be less, in a great measure, exposed to the weather. In order to remedy this inconvenience, and to give a finish to the ridges, a cap (provincially a roof) of straw is set on. Roofs thus constructed are durable, good, and cheap, and therefore much to be recommended.

*Hollow Bricks.*—The introduction of hollow bricks has of

late attracted considerable attention, and deservedly so, for there are a variety of situations and circumstances where they can be used with great advantage.

For cottage building, they are decidedly superior to any other material, as shown in the example cottages erected by his Royal Highness Prince Albert, in Hyde Park.

The buildings were erected with Roberts's patent hollow bricks, which are decidedly the best.

The greatest advantages derivable from the use of hollow bricks, are dryness and warmth, as well as economy of construction—considerations which recommend them, as a preventative of the evils so constantly experienced from dampness admitted through external walls. For agricultural buildings, and for inclosure, park, or fence walls, they are particularly adapted, as well as for the ordinary dwellings of the labouring classes, for schools and for houses generally of moderate height, and with the usual weight of roofs and floors, rendering internal battening unnecessary. Their strength may be adapted to circumstances, and where necessary, be rendered equal to that of solid bricks. When used for partitions, or for roof and floor arches, they are fire-proof, deaden sound more effectually, and are considerably lighter than solid brickwork. As a lining to stone or flint walls, they supersede the necessity for battening, and the consequent risk of fire and dry-rot is avoided. For cottage floors they are also well adapted.

The various forms of hollow bricks proposed prior to that which has been patented, are all, particularly in reference to external walls, more or less liable to the objection that they either will not properly bond together, and form a substantial wall, or else that the headers and the vertical joints afford a medium for the transmission of damp from the exterior to the interior.

By the form adopted in the patent hollow brickwork, a perfect bond running longitudinally through the centre of the

wall is secured; all headers and vertical joints passing through it are avoided; internal as well as external strength is obtained; and every facility given for the fixing of floor plates and other timbers: whilst, by the parallel longitudinal cavities, ample security for dryness is afforded, and great facility presented for ventilation, as well as for the conveyance of artificial heat, and for the transmission of pipes, &c.

According to the specification enrolled June 15, 1850, this patent includes bricks and tiles, hollow or otherwise, of such form as will secure a longitudinal bond, whether obtained by the overlapping of the alternate or the parallel course of bricks, either with a square, a rebated, or a champered joint, and with a level, a sunk, or a bevelled bed.

The dimensions of the bricks being unlimited, a size has been chosen, which, with the omission of the headers, reduces by about one-third the number of joints, and greatly improves the appearance of the work, giving it more boldness of effect and resemblance to stone, than that of ordinary brickwork, twelve inches in length, including the joints, three courses rise one foot in height—a size equally convenient for the workmen in the manufacture, and in the use of the bricks of a larger size, their form admits of ready handling and stowage for transport.

Nine patent hollow bricks of the size before described, will do as much walling as sixteen ordinary bricks, whilst the weight of the former but little exceeds that of the latter, an important consideration in reference to carriage, as well as the labour in using.

When passing through the machine, or in the process of drying, any number may be readily splayed at the end for gables, or marked for closures, and broken off as required for use; or they may be perforated for the purpose of ventilation. If nicked with a sharp-pointed hammer, they will break off at any desired line, and the angles may be taken off with a trowel as readily as those of a common brick.

A sufficient proportion of good facing bricks may be selected from an ordinary burning; and in laying them, a much better bond will be obtained than is usually given in common brickwork.

The bricks for the quoins and jambs may be made either solid or perforated, and with perpendicular holes, either circular, square, or octagonal: those in the quoins may be so arranged as to serve for ventilating shafts. Stone will be found equally applicable for the quoins and jambs, and the appearance of the work be thereby improved.

Hollow bricks may be made with any good tile machine, in the same manner as ordinary draining pipes, and about the same cost in proportion to the quantity of clay contained in them. They are more compressed, require less drying, and with much less fuel are better burned than ordinary bricks, even when waste heat, or that in the upper part of the kiln, only is used.

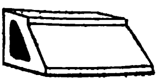
The saving in brickwork effected by the use of the patent bricks, when made at a fair price, will be from 25 to 30 per cent. on their cost, with a reduction of 25 per cent. on the quantity of mortar, and a similar saving on the labour, when done by accustomed workmen. The process of drying is much more rapid than in common brickwork; and the smoothness of the internal walls built with the patent bonded bricks, renders plastering, in many instances, quite unnecessary; whereby a further saving is effected, not only in the first cost, but also in the subsequent maintenance. If glazed on the outer face—as may be done with many clays—a superior finished surface is obtainable without plaster.

Mr. Clayton, of the Atlas Works, Upper Park-place, Dorset-square, is authorized to supply dies for making, under licence, the patent bonded hollow bricks, by his own patent hollow brick and tile machine, to which the prize of the Royal Agricultural Society was awarded at the Exeter meeting for 1850.

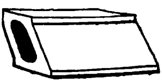
The following statement of Mr. Roberts, shows the comparative cost of bricks in a rod of reduced brickwork built with ordinary bricks of the common size, and a rod built with patent bonded hollow bricks :—

| | £ | s. | d. | | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **4300 ordinary bricks—** | | | | | | | | | | | |
| at 20s. | 4 | 6 | 0 | at 24s. | 5 | 3 | 3 | at 28s. | 6 | 0 | 5 |
| **2450 patent bonded H bricks—** | | | | | | | | | | | |
| at 25s. | 3 | 1 | 3 | at 30s. | 3 | 13 | 6 | at 35s. | 4 | 5 | 9 |
| **Saving in bricks per rod—** | | | | | | | | | | | |
| | 1 | 4 | 9 | | 1 | 9 | 9 | | 1 | 14 | 8 |

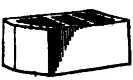
Being 29 per cent. in favour of using the patent bonded hollow bricks, in addition to a considerable diminution in the cost of cartage or transport, and of 25 per cent. on the mortar and the labour.



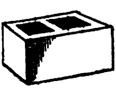
Form of hollow bricks No. 1.—For the external bricks, which, with the angle and reveal bricks, are sufficient for building 9-inch walls.



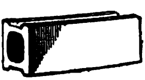
No. 2.—For the internal bricks, required to form any thickness of wall beyond 9 inches.



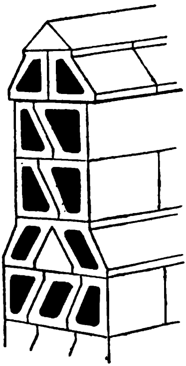
No. 3.—For angle bricks, 10¼-inches long, with one splayed corner, which answer for the quoins for 4½-inch reveals, and for jambs.



No. 4.—For reveal, jamb, and chimney bricks, 9 inches long, 4½ inches wide.



No. 5.—For 4-inch wall bricks to bond with the splayed bricks, which will also answer for floor and roof arches, not exceeding 7 feet span.



No. 6.—For chamfered or saddle-back coping, to suit a 9-inch wall, with mandrills and horses.

## CHAPTER VI.

Of the different tradesmen or workmen employed—

*The Excavator* is the first person employed, as his operations are confined to the excavating for the foundations of walls, &c., and the preparing the surface of the ground to the necessary levels, for the yards, roads, &c.; he is usually paid by the yard cube for excavating, and by the yard superficial for trimming, soiling, and otherwise forming the surface.

It is important, in taking out the earth for foundations, to see that all accidental soft wet spots through which the line of the plan may pass, be properly removed, and that the level be made up with concrete, large stones, or old bats. A good foundation upon which the building is to stand is positively necessary, yet it is the most often neglected, and very lately an instance came under my notice, of an expensive building having nearly all to be pulled down in consequence of the foundation at one angle having sunk; caused, it was discovered, by this part of the building occupying the site of a pond, and which had not been observed when the foundation was got out.

*The Bricklayer* follows the excavator, and prepares the foundation of the building by laying in a thickness of concrete or some other hard material, upon which he commences the construction of the buildings. The principal point that he has to attend to, is, first the keeping up a proper bond, by having a sufficient number of through-headers. It is a common practice with country bricklayers, when using up old bats with the new bricks to put in two bats instead of one header; both sides of the wall will appear, when finished, as though they were properly constructed, although the work would be in a most unsound state. The system of laying the bricks is either English bond or Flemish bond. In the first, the courses are laid alternately with headers and stretchers; and in the latter, the stretchers alternately with headers in the same course, with a piece of brick, called a closer, near the ends of each course, in order to break the upright joints. Of the two plans, the English is by far the stronger. Great care should be taken that the whole of the brickwork, whatever form the structure, should be self-supporting, not in any place resting upon timber that may be worked into it. All openings, of whatever kind, should have relieving arches turned over them, the lintels should only support the filling in between the soffits of the arch and itself, and be merely for the convenience of receiving the fittings for the doors and windows.

The courses should be laid true and level, and the wall built perfectly upwright, as uneven work weathers worse than when perfectly done. Hoop iron, where necessary, should be worked into the wall, it being better than bond-timber, and not more expensive.

A bricklayer will lay in one day when well served by his labourer, about 1000 bricks.

Brickwork is measured and valued by the rod, or the cube yard; the latter is used in large works, such as railways, and the former is employed in all ordinary buildings, such as we have to do with.

A rod of brickwork measures 16½ feet square, 1½ brick thick, and is called the reduced, or standard rod; it also contains 306 cubic feet, or 11⅓ cubic rods.

A rod of brickwork, laid 11 courses to the foot, will require 4350 stock bricks; if laid dry, 5370.

A rod of brickwork, laid 4 courses to gauge 12 inches, contains 235 cubic feet of bricks, and 71 cubic feet of mortar, and weighs 15 tons.

A rod of brickwork requires 18 bushels stone lime, and 3½ loads of sand; or 27 bushels of chalk lime and 3 loads of sand; or 36 bushels of cement, and 36 bushels of sand.

A hundred pecks, or 22 stricked bushels of lime, is called a hundred.

18 heaped bushels, or 22 stricked bushels, of lime is equal to 1 yard cube; the same of sand is 1 yard cube.

36 stock-bricks laid flat, or 52 on edge, will pave 1 yard superficial.

36 paving-bricks laid flat, or 82 on edge, will pave 1 yard superficial.

9 12-inch tiles, or 13 10-inch, will pave 1 yard.

9 12-inch tiles, or 13 10-inch holes, will pave 1 yard.

140 Dutch clinkers, on edge, or 125 laid flat, will pave 1 yard.

## PAN TILINGS.

180 pantiles, laid to a 10-inch gauge, will cover 1 square superficial yard.

160 ditto, ditto, to an 11-inch gauge, will cover 1 square superficial.

150 ditto, ditto, at 12 inches, 1 square superficial.

1 bundle of laths, and 1¼ cwt. of nails, required to 1 square.

1 square of pantiling will weigh about 7½ cwt.

PLAIN TILING.

760 plain tiles laid to a 6-inch gauge, will cover 1 square.

660 ditto, ditto, to a 7-inch gauge, will cover 1 square.

576 ditto, ditto, to an 8-inch gauge, will cover 1 square.

1 bundle laths and nails, 1 peck tile-pins, and 3 hods of mortar, to a square of plain tiling.

1 square of plain tiling weighs about 14½ cwt.

A hod contains 20 bricks.

*The Mason.*—The business of the mason is to construct the various walls and other works in stone. The manner of performing this differs according to the peculiar materials he has to use, but there are certain technical terms applied to the different manners of laying the stone which forms the work, that are common to all descriptions of stone. The first is called Ashlar work; in this the stone is all dressed and squared, and the whole work finished in the best manner. This is, of course, the most expensive mode of constructing with stone, and cannot, in any way be suitable for erecting agricultural buildings, as equal strength and beauty may be attained by other and cheaper methods.

The second manner is called Coursed work, in which the stones are assorted into sizes, and laid in regular courses, having been previously squared.

The third manner is called Rubble work, and is the one best adapted to the purpose in hand; in this the stones are used without being squared.

The quoins should be long and short alternately; the long ones allowed to run their full length into the wall. There should be no stone set up on end to form jambs, but several stones, lying on their bed, should form this, if strong work is required, as they have the advantage of better bond.

Mason's work is charged for by the cubical content, as it arrives at the banker or stool at which he works. The labour is charged by the superficial foot, according to its character,

whether sunk, moulded, or plain. Rubble work is charged for by the rod, as in brickwork.

Pavings, landings, and all stone less than 3 inches thick, are charged by the superficial foot; copings, curbs, &c. are charged by the foot run, dowels and mortice-holes separately. If heavy stones are to be lifted any height, hoisting is charged extra. It is important, in the erection of farm-buildings, (cheapness being always kept in view,) to use the local materials, if possible; and where this is done, I would recommend that local masons be employed in preference to strangers, as the durability of stone generally will depend upon its being laid on its true bed, and in a manner known only in the locality. On many railway works I observe the stone is crumbling to pieces from neglect of these precautions, whereas, had the stone been set by those who knew its local peculiarities and with proper care, and if previously well weathered, these same works would have stood without decay for ages.

*Carpenter.*—The business of the carpenter consists in constructing all the various floors, roofs, and partitions. The carpentry of a steading is a very important part, as upon the judicious management of the various beams, posts, ties, struts, &c., the strength of the work will depend, as well as economy of labour and materials. Carpenters, such as are usually found answering to that name, in the rural districts, are a most incompetent set, and seldom can be entrusted with the smallest thing without superintendance. They cut the stuff to waste in every direction, and use scantling of unnecessary size, and afterwards render this too weak, by cutting out a great mortise-hole for a large tenon, where none may be required. The whole of the carpentry of the steading should be designed by the architect, and superintended by some person; the dimensions of the scantling being reduced to a minimum, will not allow of being weakened by these bunglers.

The business of the joiner, in contradistinction to that of

the carpenter is, that the former uses a plane, which the latter does not use. The work of the joiner about a farmery is of so plain a character, that it may be done by the carpenter, unless it be the interior fittings of farm-houses, in which case I would recommend that joiners be employed who really understand their business, the country joiners often resembling those in the backwoods of America, the distinction between whom and a carpenter is stated to be, that the carpenter is an axe and a saw with a dollar a day, and a joiner is an axe and a saw with two dollars a day.

The labour of the carpenter is valued at per square (one hundred feet) superficial, and the labour of the joiner, at per foot superficial, according to the description of work. Mouldings and thin stuff wrought at per foot run.

*The Plumber.*—This tradesman requires superintendance as much as any one; his business chiefly consists in laying down sheet-lead for a variety of purposes; such as gutters, flats, flashings, linings, &c., &c. The lead is made in two ways: the one is called milled or rolled lead, and the other cast-lead; it is supplied at per cwt., of the various thicknesses specified, as 4lb. 5lb. 6lb. or 7lb. to the foot superficial. It is heavy and expensive, and therefore offers great temptation to dishonest persons to impose upon their employers; and, I am sorry to say, I know instances of apparently highly respectable persons contracting to lay down lead of a certain weight, and laying down something much lighter. This is not a common case: it is to be hoped that few builders would be found taking such dishonest advantages, but it is a very common case to find the light lead laid down, for the reason that the contractor sublets the plumber's work to some small man, perhaps, and neglects to look after it himself, considering that if the architect is satisfied, he ought to be; and a great injustice is done the proprietor of the buildings, by the neglect of one and the rascality of the other.

Cast-lead is manufactured sheets of lead, cast from old lead by the plumber at his own shop, (and not milled). This lead

ought not to be used for any purpose of the least consequence, as it is sure to be air-blown, and has small holes in it, through which the water is sure to find its way. Lead should never be laid for the water to stand upon it, on roofs or other places, but always have proper current found for it to run off.

Flashings should be all turned up into the joints of the brickwork, and secured with wall-hooks not more than 18 inches apart, and the joint made good with cement. All lead services and waste-pipes are jointed and laid by the plumber; and care should be taken to see he uses a sufficient quantity of solder.

Plumber's work is paid by the cwt., and lead pipes are measured and charged by the foot run, according to its size; and the joints are counted, and charged also according to the size of the pipe so jointed, and no allowance for solder is made.

*Weights of Lead Pipe per Yard.*

| | lb. | oz. | | lb. | oz. |
|---|---|---|---|---|---|
| ½ inch . . | 3 | 3 | 1¼ inch . . | 11 | 0 |
| ¾ ,, . . | 5 | 7 | 1½ ,, . . | 14 | 0 |
| 1 ,, . . . | 8 | 0 | 2 ,, . . | 21 | 0 |

*Zinc.*—This is a cheap metal, and very light, and if it can be managed satisfactorily, a great saving is effected. It is usual, in country towns, to combine the working of it with that of the plumber. It is, however, a very brittle article, and not adapted for flats or gutters, as it is easily affected by the weather, and liable to buckle up and crack.

*Glazier.*—This business is generally carried on by the same person as the worker in lead. It is valued by the foot superficial, and the price is varied according to the sizes of the squares, but such kinds as will be wanted in the construction of a farm cottage would be at once stated. It is measured between frame and frame, and the sash-bars are included in the quantity.

Crown-glass is sold by the crate, the price varying with the quality. There are three qualities, and a crate of 1st quality contains 12 tables; 2nd, 15; 3rd, 18.

*The Smith.*—As a smith's shop is a necessary part of an ordinary large homestead, it is well to construct it at once for the convenience of making all irregular iron work that may be required; but everything that is an ordinary article of commerce, such as screws, nuts, bolts, hinges, locks, latches, &c., &c., should be purchased of the ironmonger, as they are well made in the district from whence they come, at a quarter the price they could be got for elsewhere. Formerly, most of the iron-work required was wrought, now cast-iron is used for the same purpose, and answers equally well at a much less price, such as gratings, stable-fittings, gutterings, rain-water pipes.

*The Sawyer.*—In constructing a farmery, the less you have to do with the sawyer the better, as he is a most expensive assistant, and sawing will be found to form a large item in the cost of the work. It is advisable, therefore, to have the scantlings well arranged, as large a quantity as possible of the same dimensions, and as much repetition of the same parts as possible; if this be done, and the place be built of foreign timber (which, for reasons before stated, it is advisable to do), it may all be cut at the sea-port or other market where it is purchased, and when the sawing is done by machinery a great saving may be effected. In this way, if the timber off the estate be used, and the farmery of any extent, it will be worth while to fit up a circular saw-bench, to be driven by the motive power that is intended for the steading, which should be the first thing fitted up.

*The Millwright* is the most expensive tradesman required in the completion of the steading. The millwright will be required to fit up the various machines, and the motive power; to lay the shafting, and construct the necessary hoppers, shoots, spout, &c., for the efficient working of this department. In all cases this should be done by contract with some respectable house in the locality. In every locality there are persons both of capital and skill, who will undertake the completion of this portion entirely.

It is always wise to go to first-rate concerns, (such as Ransomes & May, of Ipswich; Garrett & Son, Suffolk; Barrett, Exall & Co., Reading; Hornsby, Stamford; Tuxford, Boston, &c.; and for this reason, that it is only houses of large business who have, or could afford to have, machine tools of such description as are necessary for executing millwrights' work, with mathematical accuracy, as it ought to be, and with the strictest economy, so necessary for the purpose of the agriculturist. The use of machine-tools has cheapened and improved machinery immensely, and it is impossible that little village concerns, where everything has to be made by hand, can successfully compete with large manufactories; they will often undertake to do things at as low a price, it is true, but then, "how do they do it?" Why, there is so much to be done afterwards, in alterations and re-adjustments, that they will far exceed the large houses in price for a worse article.

I do not think the same rule holds in reference to all the implements of the farm. Ploughs, for instance, may be made by a small concern quite equal, or, I will admit, better than a large one; for it generally happens that the principal, in this case, is a man of more than ordinary intelligence, and has given his attention almost exclusively to this one implement. There are several second-rate concerns that have a great reputation for one or two particular things.

And some of the larger firms, such as Howards of Bedford, devote themselves to a few things, and excel all others in the manufacture of them.

There is a certain class of men called millwrights, small jobbing fellows, who work occasionally at the little corn mills, and job about. Of these men the farmer should keep himself perfectly clear; they are a race fast disappearing, and the sooner they are quite gone the better; they are idle, ignorant, and dissolute, do very bad work, and charge a monstrous price for it.

END OF VOL. I.

RUDIMENTARY TREATISE

ON

# AGRICULTURAL ENGINEERING

**With Illustrations.**

BY

G. H. ANDREWS, C.E.

VOL. II.

MOTIVE POWERS AND MACHINERY OF THE STEADING.

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# CONTENTS.

# INTRODUCTION.

In the first division of this elementary work on Agricultural Engineering, everything which related to the arrangement of farm-buildings, was therein stated, so far at least as the limits of so small a work permitted; and the succeeding considerations in the present volume, will especially refer to the machines and implements used in connection with the farm-steading generally.

Until within a few years, no machinery was regularly employed in the homestead; all was done by hand—aided, it is true, by a few rude tools—and in many districts of England, at this time, scarcely a single machine will be found in use; and it is only now in a very few farms that any regular system of mechanical arrangements exist for performing all the home operations, with the economy and superiority that a regular set of the most approved machines will do. Certainly, one or two machines may be found on almost every steading; but they are improperly fitted up, and generally, if examined, will be found to be in a very bad state, and consequently, not half the advantage is obtained from them that would be gained if they formed part of a regular system, properly set up.

Farmers, generally, are ignorant of the principles of mechanics, and of the ordinary details of mechanical contrivances; and until they become better acquainted with them, the general introduction of arranged machinery will

not take place; for they will not buy machines until necessity drives them to do so, and when they do, it is ten to one but out of the large and beautiful assortment they have now to select from at agricultural shows, and elsewhere, they will choose one of the very worst; and that, from this simple cause—that they are not good judges of the things they buy. That this is the case, and the opinion of those who make these machines, is proved by the manner in which they try to attract and deceive the farmer, by painting the machine of the most gaudy colours,—the brightest reds, blues, greens, and yellow. This painting and decorating is only to hide the rude workmanship and bad materials, that would be evident to the most unpractised eye, unless so covered up. I do not mean to say that this is now the case nearly so much as formerly, or that it is done by the large, leading firms; but, nevertheless, wherever such things are congregated, a large number would cut but a sorry figure, if exhibited in their naked worthlessness. No attempt to deceive in this manner is made by machinists, in supplying plant to manufacturing concerns, where machinery is much employed; and for the very simple reason, that the manufacturers who employ them have taken the trouble to learn something of the principles and construction of the things used; therefore they are not so easily deceived, being much better acquainted with mechanics.

Farmers must endeavour to put themselves in the same position; for now that so large a portion of their business is performed by the aid of machinery, it is positively necessary that they should become acquainted with the principles and construction of mechanical contrivances; and this is by no means so difficult a matter as they would at first be likely to imagine.

The various contrivances for giving motion to the different parts of machines are nearly all alike. The peculiarity of the machine will usually lie in the arrangement, or some

peculiar part to which motion is given, for executing some particular description of work. It will not be difficult, then, for the farmer to make himself acquainted with the proper manner in which these ordinary points should be arranged with reference to each other, and the marks that would indicate good or bad materials and workmanship.

If I have complained of the farmers' want of knowledge of the science of mechanics, I must certainly also state, that a great many of the makers of agricultural machines are equally deficient; for worse designs, and more bungling contrivances, could not be found, than may be met with at agricultural shows, and other places, where a large quantity of machines and implements are exhibited; and this is caused by a great number of small people, mere wheelwrights, or, at most, local plough and harrow makers, attempting to construct, without tools or the knowledge necessary, agricultural machines, whose efficiency is dependent entirely upon the accuracy with which the various working parts are fitted up. These people often tempt the farmer, by asking a somewhat lower price than the first-rate makers, and he buys their paint-bedaubed libel on the real machine, carries it home, and gets it to work, when, to his surprise, it fails to do the work anticipated. After a few trials, it is thrown aside; and he, and the rest of his neighbours, set their faces against the use of machinery, to their own injury, as well as of the community at large.

I do most especially advise all those who are about to purchase the more expensive class of implements, more particularly barn machinery, of all kinds, to go to a first-rate house for what they require, and to pay a proper price; though I am sorry to see some *large firms*, who should know better, condescend to make things of an inferior quality for those who *will* cheapen.

The workshops now of the eminent makers are, in every respect, equal to those of the great engine manufacturers and

machinists. They possess the same plant and tools, for executing their work with mathematical accuracy, despatch, and studied economy. Large capital enables them to purchase materials at better and cheaper markets; character is a guarantee that they will sell that only which is what it represents itself to be. These houses, I am glad to see, are getting rid of the gaudy-coloured paints. Mr. Crosskill has exhibited all his implements and machinery at the Great Exhibition in Hyde Park, without paint of any kind,—a practice which, I am glad to see, is being imitated by many others. Messrs. Barrett & Exhall painted everything a simple lead colour; and these two stands far exceeded in appearance any others in the place.

What I have said in reference to the inability of small makers to compete, either in price or quality, with the larger firms, I do not intend to apply to the smaller implements, such as ploughs, &c., as it is quite possible that a man of superior intelligence may, from having devoted his time and ability to the perfecting of one or two implements, equal, or even surpass, the large firms in the design and workmanship of such implements. The best ploughs do not usually come from them; neglect is observable—the attention being taken up with machines of a more expensive character (though here we must except Messrs. Howard, of Bedford, and Messrs. Ransome, of Ipswich).

I think it is an admirable plan that has been adopted by Messrs. Deane, Dray, & Deane, of Swan-lane, London-bridge, to act as agents for a variety of makers, in different localities, many of whom have become celebrated for the perfection to which they have brought particular machines and implements. Messrs. Deane, Dray, & Co. have here collected under one roof the best of everything, from the different parts of England. Persons have been recommended to purchase through this house, with satisfaction. This firm, selling such immense varieties, can

always recommend that which is best for the particular locality and purpose that may be required. An establishment upon this plan should exist in every large town in England.

Whenever it is intended to fit up thrashing, cleaning, and chaff-cutting machines, as part of a regular system, most certainly one large house ought to be employed to execute it. This can be done by contract for the whole, and at a great reduction in price.

Machinery to be driven at high velocities, should be much better framed together, than the machines usually sold as separate machines. Where one house fits up the whole barn-work in a piece, they will have opportunities of arranging the frame-work on a much better plan to ensure steadiness of working. The same parties should always be consulted previously to the construction of buildings that are to contain the machinery, so that proper arrangements may be made for the foundations and bearings, as well as leaving the necessary apertures in the walls for the shaftings and bearings. This will save unnecessary expenses for iron and wood carriages, and framing to support the gear. The architect should always be put in communication with the machinists as early as possible, that they may agree upon the arrangement, as well as making the necessary provision for plant.

Eminent agriculturists are divided in opinion, as to whether it is better to have a fixed engine, and the barn machinery regularly fitted up in a building, and bring the corn to the machine; or to have a portable engine and thrashing-machine, and take the machine to the corn. No doubt, there is a great deal to be said on both sides; and on very large farms, with out-lying land, it is a most convenient thing to thrash in the field; and the portable agricultural engine has been so improved and perfected, as well as the large portable thrashing-machines, that field-thrashing

is, doubtless, done with great facility, and in a very perfect manner. Nevertheless, I do not myself think the system is so good as having the engine fixed, and the whole plant to form part of a regular plan. It is found in all manufacturing operations that the more concentrated the machinery, and the more all the operations are got together, and under one general management, the better it is; and I cannot see why the manufacturing manner in which farm operations are now, and must every day still more become, should be an exception to the rule; but of this it is certain, that fixed machinery, permanently fitted up, will always do the work a great deal better, and more economically, than portable machines of any kind;—that a fixed steam-engine and boiler, of judicious design, will consume a much smaller amount of fuel, and last much longer, with scarcely any repair, than a portable engine, the repairs of which will be found enormous, as compared with the fixed engine, when extending over a number of years.

I am inclined to think that the preference is given to portable engines, chiefly because of the want of properly-contrived homesteads. The work requiring to be done is distributed about, instead of being concentrated, and brought under one roof; and often there are two or more small sets of buildings in the same farm, instead of one general homestead. Under these circumstances, scarcely any other than a portable engine could be used; but when a regular system of railways is laid down to every part of the farm, and the liquid manure delivered through pipes to every field, portable engines will cease to be required, and the advantages of fixed ones of large size fully appreciated; every duty that can will then be thrown upon it, and but few days in the year will this important auxiliary of the farm be suffered to remain idle.

# CHAPTER I.

## THE STEAM-ENGINE.

The steam-engine is the real motive power upon which farmers will have to rely; for, although in no case where water power *can be got*, should it be neglected, yet it will be but with a comparatively small number of steadings that this power is available. Windmills as motive power are not to be thought of, and horse-gear work will only be used on exceedingly small farms.

We have no space here to discuss whether the steam-engine should be erected by the landlord or not: the general opinion seems to be that it is to be considered as a part of the ordinary dead stock of the farm, and that he will carry it from one farm to another, the same as he now does a cart or waggon. The advantage of having one is now generally admitted, so that our object must now be to lay before the farmer, in as concise a manner as possible, some account of this valuable machine, and the various forms in which it is constructed, and endeavour to point out which is the most suitable for his purpose; for, although steam-engines have been and are daily being constructed upon all sorts of plans, yet it is only a few of the simplest of these, and of such as have stood the test of experience, that can be considered at all adapted to the purposes of agricultural engines. The first steam-engines erected for performing the heavier duties of farmsteads were erected in Scotland about 1825, and are still in constant use: they were all of the condensing reciprocating description, and, though erected at a great cost,

have not deterred the enterprising agriculturists north of the Tweed from continuing erecting such and more suitable engines up the present time; and now in Scotland nearly every farm of any extent is provided with this valuable auxiliary.

As this little book is an elementary treatise, and intended for the perusal of farmers, and not engineers, it may not be out of place to describe the principle and manner in which steam is made to play so important a part; and those who have a little knowledge, as well as those who have none at all, upon the subject of steam-machinery, I recommend to peruse Dr. Lardner's elementary treatise, written expressly for this series of Mr. Weale's rudimentary volumes;—they will there find the subject treated in the simplest possible manner, yet sufficiently detailed as to give a good general knowledge of this important subject.

The mechanical action of steam is usually accomplished by a piston moving in a cylinder. The cylinder is a tube in most cases of a greater length than the proportion of its diameter.

The piston is a plug fitted accurately to the bore of the cylinder, not so tightly as to prevent its being easily slid from one end of the cylinder to the other, yet sufficiently so as to prevent the passage of steam between it and the side of the cylinder.

Attached to the piston on one side, in its centre, is a circular bar of iron, accurately turned from end to end, called the *piston-rod.*

Each end of the cylinder is closed by lids, through one of which the piston-rod passes; this is kept perfectly steam-tight by a packing of hemp soaked in oil and tallow.

A blast of steam being admitted on one side, the piston is forced onwards to the other end, and a similar blast being admitted on that side (and the means of escape being opened on the other), the piston is then pushed back to its former position; thus the primary motion produced by steam power is an alternate motion backwards and forwards in a straight

line; but by an infinite number of well-known mechanical contrivances, this alternate motion may be made to produce any other kind of motion that may be desired; thus, we may make it keep a wheel in constant rotation, or move a weight continually in the same straight line, and in the same direction. The various details by which these objects are effected, and which constitute the working parts of the engine, we will now proceed to describe separately.

First, the means by which steam is admitted into and allowed to escape from the cylinder. This requires two apertures to be made at each end of the cylinder, one for the admission, and the other for the escape, of the steam; the first must have a communication with the boiler, and the latter with the vessel where the steam is condensed, as in condensing engines, or into the atmosphere, where it escapes, as in high-pressure engines.

These apertures, or steam-ports, must of necessity require to be alternately opened or shut, which is done by contrivances called puppet-valves—those which open a communication with the boiler being called steam-valves, and those which open the communication with the condenser are called exhaust-valves.

These valves are conical discs, fitting lightly into holes, from which they are lifted or drawn, and to which they return alternately: they are made of gun-metal, with their faces ground so as to fit with the greatest precision.

In lieu of these valves an arrangement is often made for effecting the same end by what are called slides. The two openings to the cylinder in this case, being ground to a flat surface, upon these two plates or discs, also ground to a true surface, pass backwards and forwards, thus covering or uncovering by pairs the openings for the admission or escape of the steam.

The manner in which these valves act is thus: supposing the cylinder to be placed in a vertical position (which it is

not always), when the piston arrives at the top of the cylinder, two valves, the upper steam-valve and the lower exhaust-valve, are required to be opened, and at the same moment the two other valves, the lower steam-valve and upper exhaust-valve, must be closed. Now, as all these movements are simultaneous, it may be easily imagined that the four valves may be so connected that a single movement imparted to them should open one pair and close the other.

When the piston arrives at the bottom of the cylinder, a single motion in the contrary direction will evidently effect the object to be attained, that is to say, to open the lower steam-valve and upper exhaust-valve, and close the upper steam-valve and lower exhaust-valve. This will be better understood by reference to fig. 1.

Fig. 1

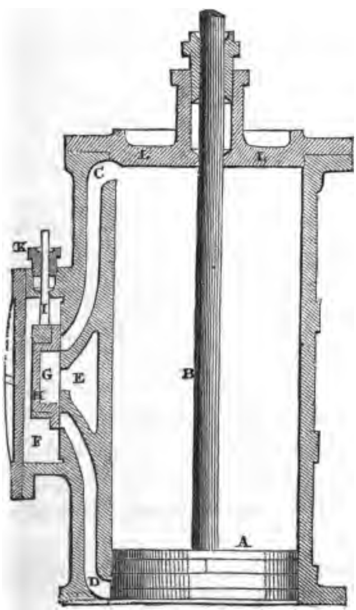
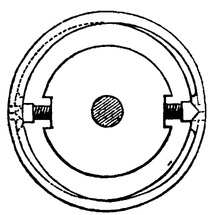



Fig. 2.

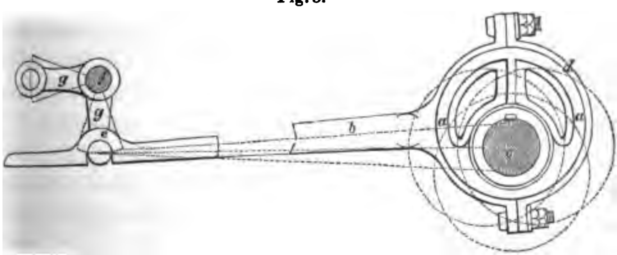


METALLIC PISTON.

To render the engine self-acting, some contrivance must be adopted by which these valves will be regularly opened or shut by the action of some part of the engine itself. In the early history of the steam-engine, a boy was employed to open and shut these valves, but they only made six or eight strokes per minute in those days. A boy so employed, named Humphrey Potter, was the first who made the steam-engine self-acting by adding what he called a scogger; that was a contrivance attached to a portion of the machine in motion, which opened and shut the valves, during which time the boy was enabled to scog or skulk. This was the origin of what is called hand-gear, and which is still attached to some large engines, but not to any likely to be used by agriculturists except for the purpose of lifting water, which will be found described in Part III. of this work.

The means generally adopted for opening and shutting valves and working slides is by what is called an eccentric, as seen in fig. 3.

Fig. 3.




This consists of a circular plate of metal, A A, fixed upon a shaft, E, at some distance from its geometrical centre. Round this eccentric point it is made to revolve, and in revolving it is evident that its geometrical centre revolving round its centre of motion will be thrown alternately to the right and left of such centre.

Round this circular disc is placed a ring, *d*, within which it is at liberty to turn, but not to turn the ring with

it; the ring will consequently be thrown alternately to the left and right of the centre on which the eccentric plate is made to turn, and the throw or length of its play right and left will be equal to twice the distance of the geometrical centre of the disc to the centre on which it actually turns. To this ring is attached a bar, *b*.

As the centre is thrown alternately right and left of *e* by the revolution of the disc, the point *e* receives a horizontal motion, right and left, to a like extent. The motion is transmitted by means of the levers, *g g*, to the slides of the cylinder by the mechanical arrangement shown in the cut.

With whatever force the piston be impelled, the effects of that force will be augmented just in proportion to the amount of vacuum produced in that part of the cylinder towards which the piston is pressing. Now, if one cubic foot of steam be reconverted into cold water, it will be reduced to one cubic inch of liquid, and we shall get the entire cubic foot (minus one inch) of vacuum, and therefore for every cubic foot of steam in the cylinder, we shall have a cubic foot of vacuum, minus one cubic inch. It is this advantage that is sought to be obtained by using what are called condensing engines, and it is to the genius of Watt that the great difficulty of condensing the steam without cooling the cylinder has been overcome; for previous to his time (1763), the steam was condensed in the steam cylinder, which was consequently cooled down at every stroke of the engine. It will not be difficult, then, to form an estimate of the enormous value of this discovery of Watt's, and the great advance made in steam machinery dating from that time, when the process by which he effected it is considered. Watt's invention consisted in the producing an almost perfect vacuum without in the slightest degree lowering the temperature of the steam cylinder, and this he effected by placing near the cylinder another vessel submerged in cold water, and having a jet of cold water constantly playing within it.

Whenever he desired to condense the steam in the cylinder, he opened the communication by a valve between this vessel and the cylinder, and immediately the steam, by its elastic force, rushed into this vessel and was instantly condensed, leaving in the cylinder an almost perfect vacuum, and at the same time exposing the cylinder to no cold which could in the slightest degree lower its temperature.

Now, the second vessel, or condenser, would in time become filled with water from the jet, and condensed steam, as well as air, which would enter in a fixed form in the water, and which would be liberated by the warmth of the steam condensed by the water. This air would, to a considerable extent, vitiate the vacuum in the condenser. These impediments were surmounted by the adjunct of a pump to the condenser, by which the water supplied by the jet and the condensed steam, as well as air, were constantly pumped out by an apparatus called the air-pump.

To prevent the water surrounding the condenser from becoming warm, there is placed a pump and waste-pipe—the pump for supplying cold water, which, by its superior gravity, sinks to the bottom of the cistern, and the waste-pipe to carry off the warm water which, being lighter, rises to the top. In this state did Watt leave the steam-condensing apparatus, when he died, and so it remains to this day; for it has been remarked that the history of the steam-engine ends with Mr. Watt's labours.

Having, by the means which we have described, produced a continual self-acting reciprocating action of the piston, the next thing is to apply that motion to the machinery required to be moved, and this is done by attaching it at once to a beam, called the working beam: this is supported on a fixed axis, and alternately vibrates upwards and downwards as it is moved by the action of the piston through the piston-rod.

Now, it is evident that the ends of the beam to which the

piston would be attached could not move upwards and downwards in a straight line (as the piston-rod does), but must describe the arc of a circle, whose centre would be the axis upon which the beam vibrates.

The piston-rod, as we have before described, is an accurately turned bar of iron, working through the centre of the cylinder-cover, and kept securely in that position by the packing in the stuffing-box, and unable to swerve to the right or to the left; consequently, if the head of the piston-rod was fastened to the end of the beam, it would be strained and bent by the motion of the beam. To remedy this inconvenience, it is necessary to place between the end of the beam and the top of the piston-rod a piece of mechanism called the parallel motion, which accommodates the curvilinear motion of the one to the rectilinear motion of the other. This is formed in a variety of ways; but the most common is the arrangement invented and used by Mr. Watt, and is considered one of his brightest thoughts: it is a continuation of rods, so arranged and joined together that while one of their pivots is moved alternately in a circular arc, like the end of the beam, some point upon them will be moved alternately upwards and downwards in a straight line. This will be readily understood by reference to the plate.

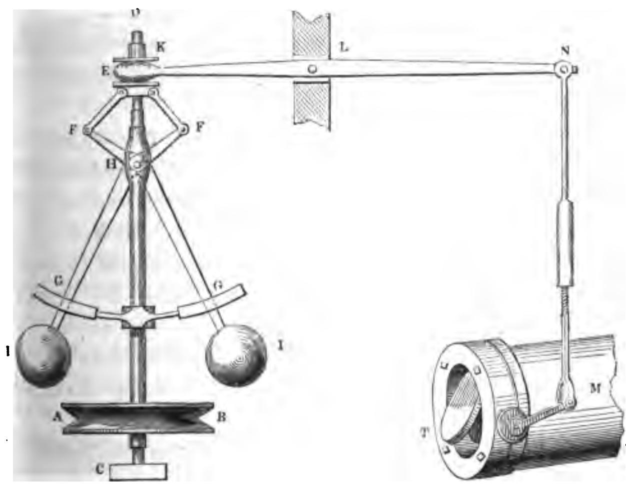
As nearly all motions that are required for driving the machinery of mills are effected by the constant turning of a wheel upon a shaft, it is necessary now to convert this reciprocating motion in a straight line, to which we have now arrived, into, as nearly as possible, a continually acting rotatory one, and this is generally effected by another invention of Watt's, called a crank. This is an application of the ancient method of giving motion to the potter's lathe, the original inventor of which is unknown, and even the era of its introduction.

The crank is an arm attached generally to the centre of

the wheel, which it turns in the same manner as the motion is imparted to a winch or windlass—a thing of such common application, that it can require no description here. As a matter of convenience, in those engines worked with a beam, there is interposed between the end of the beam and the crank a strongly formed bar of iron called the connecting-rod.

Having by the means we have briefly described now got a self-acting machine ready to apply to any purpose required, there remains only one other point necessary to be attended to,—and that is of considerable importance,—being the means by which the power we have got may be kept within bounds, when inclined to exert itself too much, or stimulated when inclined to flag; and it would be continually falling into the one error or the other, however well the machinery might be constructed, as the work it was employed to do might increase or decrease in load upon it. To remedy this defect, Mr. Watt adopted an ingenious contrivance which is now called the governor, shown in fig. 4.

Fig. 4.



A similar irregularity to the one we have described, occurred in the motion of corn-mills, from the varying quantity of water or resistance. It had early exercised the ingenuity of millwrights to obtain some means by which its injurious effects could be obviated, and the means they adopted was attaching a couple of heavy balls to a jointed rod. These balls were made to revolve by being connected with the spindle or axis of the mill-runner, and the apparatus was called a lift-tenter. The centrifugal force of these balls when in motion either raised or lowered a stage in which the arbor of the spindle revolved, and brought the stones nearer, or removed them farther from, each other, as they might require to be adjusted. This most ingenious regulator Mr. Watt applied to regulate the opening and shutting of the throttle-valve of the steam-engine. Fig. 4 shows the manner in which this is effected. I I are two balls attached to two rods H G; when the balls separate so that the rods H G become more divergent, the arms H F open, and the pivots F separating, draw down the collar E, which slides on the spindle. When the balls, instead of diverging, approach each other, the arms H F also approach each other, and the collar E is lifted. Thus, as the balls, by the action of centrifugal force, diverge or contract towards the seat they occupy when the engine is at rest, the collar E is raised or lowered by means of a lever, N L K, having a fork formed at one end, which receives the motion of the sliding collar E, and transmits it to the lever of the throttle-valve, as shown in the cut. A rotatory motion is given to the balls by a strap, gut-line, or gearing to the pulley A B (fixed upon the lower part of the spindle) from any convenient part of the machinery in motion.

As it is necessary that the boiler be supplied with water equal to that evaporated and consumed by the engine in the shape of steam, it is usual to employ the power of the engine to work pumps for that purpose. In condensing-

engines, the water is supplied to the boiler from the condenser, extracted by the action of the air-pump, as this water is considerably warmer than that drawn direct from the original source, and is of course a saving of so much heat. As this supply of water requires to be merely regulated, a self-acting apparatus is attached to the boiler, as shown in fig. 15; but this arrangement is only applicable to low-pressure boilers, as the column of water or head would require to be inconveniently high to overcome the great pressure of the steam in the latter case. Therefore, forcing or feed-pumps are attached to the engine, and an arrangement made by which the driver can regulate the quantity supplied, which he ascertains by means of the gauge-cocks, or glass gauge-tube, shown in fig. 20.

Having now lightly passed over the leading features of the ordinary method for applying the elastic force of steam to the working of machinery, we may now proceed to a description of the various and most approved forms in which the steam-engine is constructed, and the various parts we have discussed, arranged in the most suitable manner for the purposes of the agriculturist.

The Boulton and Watt condensing beam-engine is doubtless the most perfect machine, and the most economical form in which steam power can be applied, especially when to it are added some of the most recent improvements for working the steam expansively, and in two cylinders; the engine may be considered in this form, almost perfect, and I have lately had an opportunity of examining one of this description of most excellent design and workmanship, at a corn-mill at Wandsworth, in Surrey, belonging to Mr. Watney. This engine is working twenty-three hours out of every twenty-four, and doing about twenty-five horses' power the whole of that time, with seven tons of coal per week; a most excellent duty; it was manufactured by Messrs. Wentworth of Wandsworth, and does them infinite credit.

On all very large farms, where a large power can be constantly employed, I should recommend engines of this description, but as these cases must be but very few in number, something *much cheaper*, much more easily managed, and much simpler in its action must be sought for. In Part I. of this treatise I have given the reasons why I think farmers should not go to the expense of erecting such costly machinery as is used by regular manufacturers, even supposing such to be to the manufacturers a little more economical in the end. The farmer, as I have before observed, is differently placed, inasmuch as his machine is only employed for a certain portion of the year, while the manufacturer is constantly employed, almost day and night, in producing minute portions of profit. The farmer may save more in interest upon dead capital sunk in machines, than he would in the saving he might get by having them so much more expensively constructed. For agriculturists they must be made at a low price; for farmers' profits in future will not admit of the smallest amount being sunk unnecessarily in the construction of their machines, which must of necessity be expensive under any circumstances.

*The high pressure beam-engine.*—This is the form of engine oftenest adopted on large farms; it is constructed in much the same manner as the condensing engine before described, that is with beam parallel motion, connecting-rod, crank, and feed-pump; and is generally constructed with an iron frame supported by columns similar to condensing engines, but it has neither condenser nor air-pump. This engine is manufactured by all the leading firms, as Ransomes', Garrett's, Tuxford, Hornsby, &c.

Now, however cheaply this engine may be got up, it must be expensive on account of the number of parts employed in converting the rectilinear motion of the piston-rod into the rotatory one of the shaft. It has been, therefore, a point much aimed at by the builders of engines to get the

piston rod to act as directly upon the crank as possible, and so produce what are called direct-actimg engines; this has been done in the following different plans; first, by working a cross-head attached to the top of the piston-rod between guides, and placing a connecting-rod between the crank and the head of the piston-rod: an exceedingly simple engine has been constructed upon this plan, and it answers very well in practice. Its defect, of course, consists in the friction of the cross-heads against the guides, and the thrust and pull of the piston-rod being so much out of the straight line, as it must of necessity be by the throw of the crank. This defect gets less apparent as the connecting-rod is made longer. A variety of agricultural engines have been constructed upon this plan, with long connecting-rods and high frames.

The next method is by having the cylinder set upon a point or points in the centre upon which it is allowed to oscillate; in this case the head of the piston-rod is attached at once to the crank, and an exceedingly simple engine is produced. This ingenious method of getting rid of parallel motions, beams, and connecting-rods, was the invention of Mr. Watt, who seems to have left nothing to do by those who followed. In some books upon the steam-engine this invention is attributed to Mr. Whittie, and it certainly was brought into use by Mr. Maudslay. Doubtless the same notion occurred to Mr. Whittie as had previously occurred to Mr. Watt; that he invented and made a working model of it there is no doubt, for at the Great Exhibition in Hyde Park, upon the frame of the Great Boulton and Watt Marine Engines, there was placed by that firm the identical model, made by McMurdoc, at Soho, 1763. The cylinder case was of wood, and the model very roughly got up; nevertheless, the oscillating engine was perfect; the action of the slide was arranged in the same manner as it is commonly worked now, and the engine was in appearance the

ordinary oscillating engine of the present day. It being my duty to report upon agricultural and other machines for the Illustrated London News, I prepared a cut of this engine, and it will be found in No. 499 of that paper, about a third the size of the original. Beside this first idea of Watt's of oscillating the cylinder, were exhibited a pair of oscillating cylinder engines by J. Penn, of Greenwich, of extreme

Fig. 5.

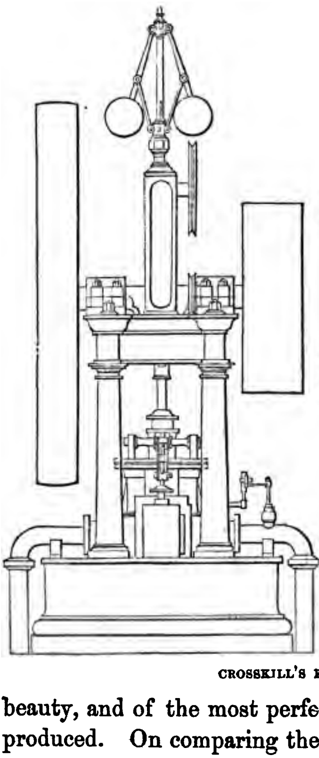
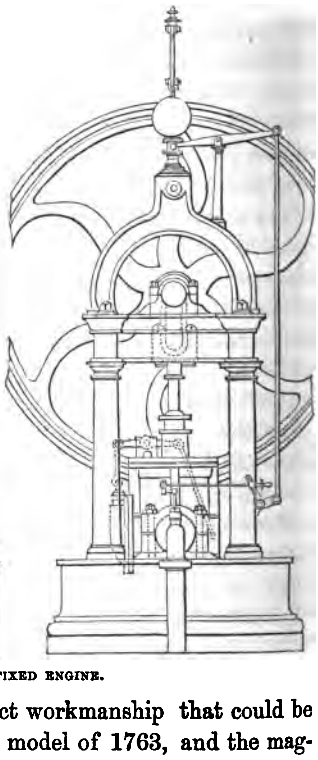


Fig. 6.



CROSSKILL'S FIXED ENGINE.

beauty, and of the most perfect workmanship that could be produced. On comparing the model of 1763, and the magnificent engines of 1852, one cannot but be struck with the fact that, in the model the idea was complete; it required

but to be carried out as Mr. Penn could do it. An immense variety of the oscillating cylinder-engines have been constructed; sometimes it is placed horizontal with one trunnion, at others it is placed overhead and the crank underneath. In this manner it is called a pendulous engine. Another arrangement, and one I consider well adapted to agricultural purposes, has been manufactured by W. Evans, of Wardour Street. In this case the steam is inducted and discharged through transverse hollow trunnions, placed at the bottom of the cylinder, of a simple and scientific construction, upon which the cylinder moves. Doubtless the oscillating engine is the simplest form upon which a steam-engine can be constructed, and fixed agricultural engines are usually made on that plan; but there is one point upon which some difficulty exists, that is, the keeping the packing at the trunnions always in order; this requires considerable care and attention, which it is difficult to extract from ordinary agricultural labourers. Figs. 5 and 6 represent one of the best forms in which this engine is made for agricultural purposes; it is by Mr. Crosskill of Beverley in Yorkshire; it is simple in design, exceedingly strong, cheap in price, and in setting up requires only a flag-stone or two wooden sleepers.

In every respect this is to be recommended as an efficient farm-engine; it occupies but a small space, and is, therefore, well adapted for the colonies.

*Trunk-engines.*—The object of adopting the contrivance called a trunk, is to get the direct action of the oscillating engine without the inconvenience of vibrating the cylinder, and this is effected in the following manner:

In the centre of the piston is placed an iron tube or trunk, and in the cylinder cover is an aperture through which it passes, being kept steam-tight in the same manner as the ordinary piston-rod. One end of this tube is connected with the piston, and the other end is open. No piston-rod is required to this engine, as one end of the

connecting-rod is fixed to the piston itself, and the other end to the crank.

It will be easily understood now, that the deviation of the connecting-rod from a line parallel to the sides of the cylinder, will be permitted within the trunk or tube which works in and out of the cylinder as the piston rises and descends; the trunk, in fact, may be considered as a hollow piston-rod of sufficient diameter to allow of the swaying the connecting-rod within it equal to the throw of the crank.

Messrs. Penn, of Greenwich, are the introducers of this engine for marine purposes, to which it is specially adapted; and Messrs. Ransomes have adapted it for a small fixed engine for agricultural purposes, as well as to their portable engine.

It is certain that the trunk simplifies the action of the engine to a great extent, and, but for one defect, seems to me to be an almost perfect engine. This defect is the constant exposure of a large surface, like the trunk, to the external atmosphere to be cooled down at every stroke of the engine, for the atmosphere is not only in contact with the outside of the trunk each time it is drawn from the cylinder, but is always cooling down the inside surface of the tube which, at the bottom of the stroke is, of course, the whole length of the cylinder. The steam must be badly situated here, being only an annular ring cooled down from the outside of the cylinder, and the inside of the trunk; but Messrs. Ransomes' have tried these engines, and in practice it may be that these causes do not produce such appreciable effects as might be anticipated. An excellent specimen of this engine was exhibited by them at the Great Exhibition, and was employed in driving Mr. Whitworth's beautiful collection of machine tools. It is intended for the use of farmers and millers, and is thus described by the makers:—"All the parts are easy of access,

and afford every facility for adjustment and repairs. It is entirely supported by its own cast-iron frame, which is strong and neat, and does not require any attachment to the walls of the building in which it is placed; it can be either erected on a small brick-work foundation, or be placed on two wooden sleepers. It is well adapted for driving fixed thrashing machinery, either on a stage or ground floor, as the strap can be easily taken from the large pulley on the crank-shaft, to the small one on the drum-spindle of a thrashing machine, which may have been previously driven by horse-power. The engine has a wrought-iron crank shaft and connecting-rod; the slide valve is brass and on the best principle, and not liable to be put out of order, and the supply of water to the boiler is very easily regulated; there is a governor of the best construction, and an improved valve for stopping the engine without interfering with the throttle-valve.

*Rotatory Engines.*—It has been the aim of nearly all the constructors and improvers of the steam-engine, to construct one in which the force of the steam exerts itself continually in producing direct motion round an axis, so getting rid of all the cumbrous parallel motions, beams, connecting rods, &c. Engines acting in this manner are called rotatory. An enormous number of patents have at various times been taken out for them, but as yet there are not any sufficiently perfect in their action as to be available for agricultural purposes, nor is the loss of power from the employment of cranks and the other members of reciprocating engines nearly so great as to render it necessary for the farmer to run any risks by adapting any of the present rotatory engines. Mr. Scott Russell, in his treatise on the steam-engine, observes, "that such an elementary machine, if constructed, could give forth any more of that power than is now rendered effective by the common steam-engine in every day use, is a fallacy, arising in ignorance and ending

in disappointment." Rotatory engines have been brought to considerable perfection by Mr. Beale, Lord Dundonald, Elijah Galloway, and many others; but the one that seems most likely to realise the anticipations of its inventors is called a disc-engine, and acts in a manner quite distinct from the usual plans, attempted much in the manner the upper arm of a man works from the shoulder joint.

Those who are desirous of further information upon this subject, will find the disc and many other rotatory engines fully described and ably discussed in Mr. Ritchie's work called the Farm Engineer.

## CHAPTER II.

### PORTABLE STEAM-ENGINES.

THE manufacturers of agricultural steam-engines have spared neither pains nor expense in endeavouring to produce a perfect portable engine. At the Great Exhibition in Hyde Park, there was quite an array of them; nearly every engineer of eminence had produced one constructed upon the most approved and tried principles, and all were so good, though differing considerably from one another in design, that it is a most difficult matter to decide which is actually the best, for, although one may have an advantage in some particular point, yet upon inquiry it will be generally found that it has been obtained at the sacrifice of some other, which its maker considered too important to be neglected. We need not, therefore, attempt to make comparisons where all are so good, but will give a short description of some of those which upon trial were found to answer thoroughly well, and received the commendations of the judges whose business it was to decide upon their respective merits.

*Messrs. Garrett's Engine.*—This eminent firm always make a great display of implements of every description, sparing neither pains nor expense to enable them to occupy the first place in the continually renewed struggles for pre-eminence as agricultural machinists; and it but rarely happens that they are not the recipients of some of the prizes awarded for inventions, improvements, cheapness, or superior workmanship. Their portable engine, as may be expected, is one of the best constructed, having every modification or addition applied immediately its advantage was apparent. Figs. 7, 8, and 9 represent the fore and after end and side elevations of this engine.

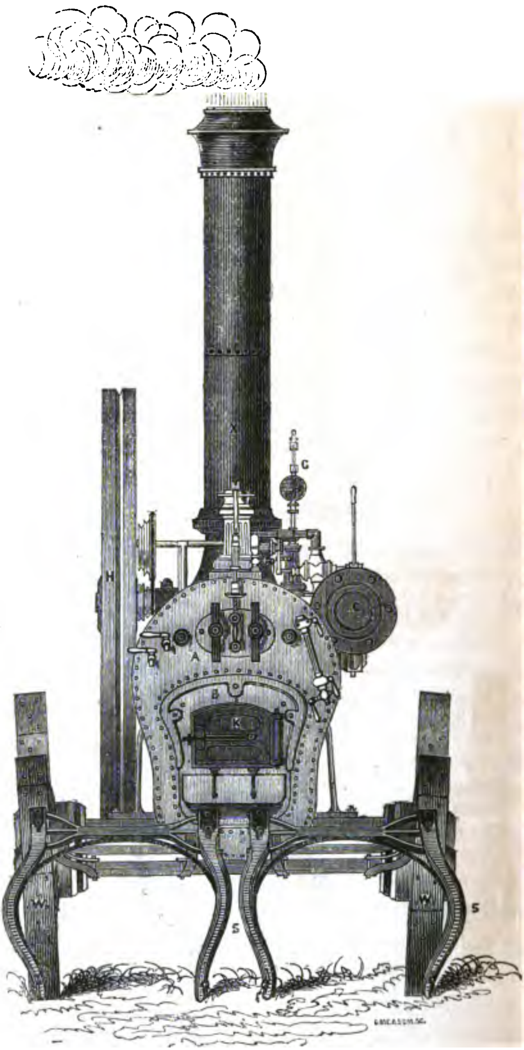
It is fitted with governor, hair-belt jacket, steam and water gauges, and other necessary appendages, mounted on four strong carriage-wheels, with shafts, and may be easily transported from place to place by two horses.

*Reference to Plates.*

| | |
|---|---|
| A A A | An improved tubular boiler with oval fire grate. |
| B B | Fire-box of boiler. |
| C C | Cylinder of engine. |
| D | Improved guide to piston-rod, capable of being adjusted. |
| E | Eccentric rod for working the slide. |
| F | Connecting rod. |
| G | The governor, for regulating the speed. |
| H H H | The fly-wheel. |
| I I I | Cold water tank, to which is attached the pump for supplying the boiler. |
| W W W | Travelling wheels. |
| S S S | Shafts for two horses abreast. |
| V | The safety-valve, with Salter's improved balance. |

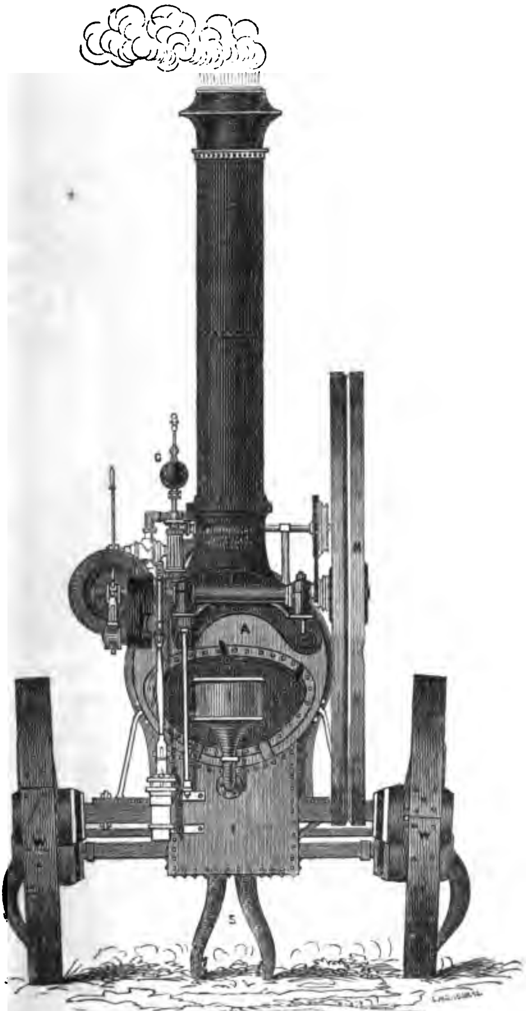
Since these cuts were prepared, this engine has been considerably lightened, and now only one pair of shafts is used instead of the arrangement shown in the cuts.

Fig. 7.—Fore-end elevation.



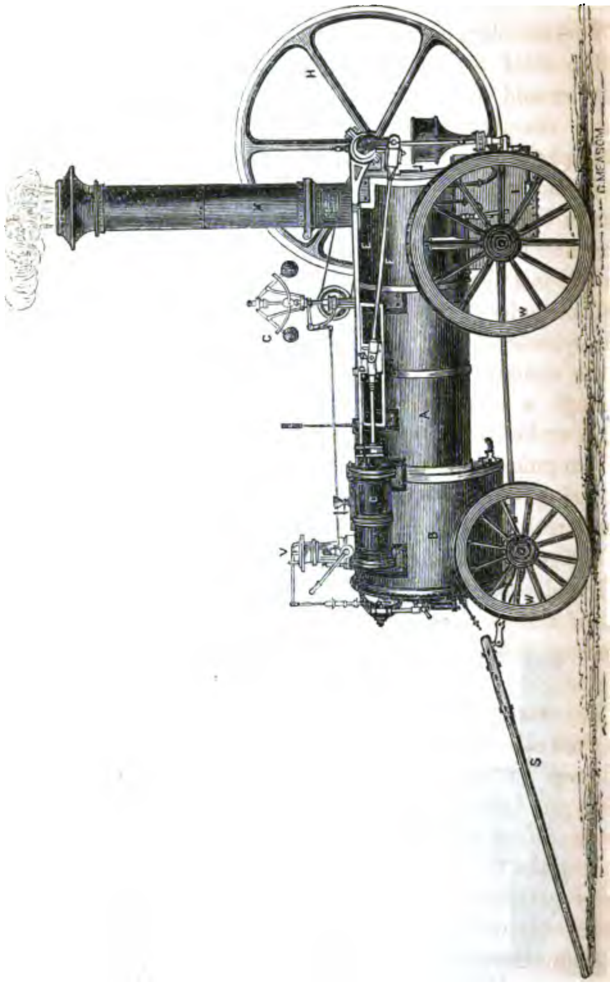
GARRETT'S PORTABLE STEAM-ENGINE.

Fig. 8.—After-end elevation.



GARRETT'S PORTABLE STEAM-ENGINE.

Fig. 9.—Side elevation.



GARRETT'S PORTABLE STEAM-ENGINE.

*Messrs. Hornsby's Engine.*—This firm has brought the agricultural portable engine to the highest point of perfection in workmanship, and in economy of fuel in producing steam.

The chief peculiarity in this engine is the placing the cylinder and pipes connected therewith inside the boiler, or steam chamber, so effectually protecting them from the atmosphere at all times. This improvement no doubt effects an immense saving of fuel, as it does away with all condensation in the cylinder; and the less fuel is consumed, the less wear and tear there will be in the tubes and fire-box, which are the most hard-wearing parts.

This engine is exceedingly neat and compact in appearance. The cylinder (as we have before remarked) is placed in the steam chamber over the furnace, the piston-rod working through a stuffing-box in the fore-side of it; and on the outer end of the piston-rod is a short cross head which works in two guides, which are neatly supported at the outer end by a ring, the lower part of which is screwed to the top of the barrel of the boiler.

The connecting-rod is attached to the head of the piston-rod and cross-head, and, as the piston-rod passes in and out of the cylinder, the connecting-rod has room to play in the ring in a manner similar to what it would in a trunk-engine.

The crank-shaft is supported on two plummer blocks one on each side of the boiler, a convenient distance aft of the chimney or funnel. The plummer blocks are placed on carriages formed of three short fluted Doric columns, the abacus of each being the lower portion of the plummer block: the whole is placed upon a step projecting from the boiler. It is very handsome in appearance, and quite secure and steady when working.

Above the guides for the piston-rod cross-head is placed an exceedingly well contrived governor, with an additional security for the heavy balls when the engine is travelling—

two semispherical cups being placed so as to receive the balls and keep them at rest, as their weight is apt to injure their bearings by jolting on rough roads.

The engine is fitted with metallic piston, steam-cocks, gauge-cocks, safety-valves, and all other requisites for ensuring correct working and safety.

Prizes have been awarded to the Messrs. Hornsby at the Exeter and York meetings of the Royal Agricultural Society, and the great Prize Medal at the Exhibition of all Nations, as well as by a number of local societies. At the meeting of the Royal Agricultural Society at York, the judges say, "they awarded the prize to this engine because it was stronger, steadier, better fitted, got up the steam and worked with less fuel than any other engine exhibited. It worked in every way as the exhibitor described it. It had a good boiler, to generate the steam, plenty of cylinder room to give it power, sufficient strength in all its parts to keep it steady, and an excellent governor to regulate its motion."

A more flattering report never was made nor better deserved. This engine is the result of repeated improvements and careful study of the peculiarities of engines required for agricultural purposes. Though highly scientific in its arrangement, it is nevertheless exceedingly simple; and the charge I hear repeatedly made against it, that it is difficult and expensive to repair (in consequence of the cylinder, &c., being enclosed), I am assured by Mr. Hornsby is utterly without reason: they undertake to take to pieces and reconstruct their engine in the same time that any other can be so treated. Nor do I see any difficulties arise from the situation of the cylinder, there being a manhole directly over it.

At the trial of steam-engines which took place under the direction of the executive committee at the Great Exhibition, the Messrs. Hornsby's engine, competing with others

manufactured by various makers from all parts of England, beat them all in amount of duty, the consumption of fuel being only 6¾lb. of coal per horse power per hour; or 3 cwt. 2 qrs. 13 lb. of coal per day for a six-horse engine.

At another trial (the power in both cases being proved with a dynamometer), at the North Lincolnshire Agricultural Society's meeting, held at Caistor, July, 1851, the first prize of 20*l.* was awarded, the result being reported thus:—

Their engine was of seven-horse nominal power, and consumed 36lb. of coal, on getting up the steam 37lb. per hour, being 5·28lb. per hour per horse, and 3 cwt. 1 qr. 6lb. per day of ten hours, when working up to their nominal power the whole time.

At another trial at the Yorkshire Agricultural Meeting, held at Bridlington, August, 1851, the prize was again awarded to this engine, the results being thus with four engines, from the hands of first-rate makers, Messrs. Hornsby's being No. 1:—

| No. of engine. | Nominal horse power. | Coals used in getting-up the steam. | lb. of coal burnt per hour. | lb. of coals burnt per horse-power per hour. | Coals used per day of 10 hours, when working up to their nominal horse-powers. | | |
|---|---|---|---|---|---|---|---|
| | | lb. | lb. | lb. | cwt. | qrs. | lb. |
| 1 | 7 | 40 | 51½ | 7.35 | 4 | 2 | 11 |
| 2 | 7 | 41 | 59½ | 8.50 | 5 | 1 | 7 |
| 3 | 6 | 48 | 64¼ | 10.70 | 5 | 2 | 26½ |
| 4 | 6 | 60¾ | 96¾ | 16.12 | 8 | 2 | 15½ |

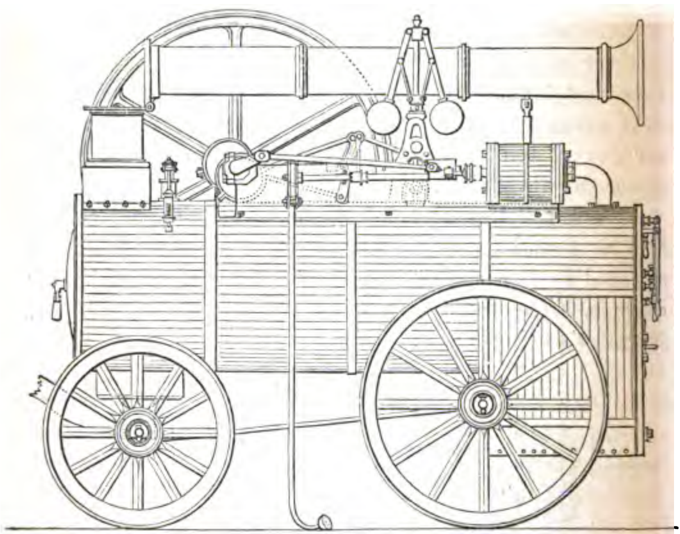
In this trial an inferior coal was used, which accounts for the increased consumption in doing the same amount of work.

The engines of this firm have now stood the test of years, and I most confidently recommend them as being, if not superior, at least equal to anything of the kind manufactured by any one.

*Portable Steam-Engine*, constructed by Messrs. Barrett, Exall, and Andrewes, of the Katesgrove Iron-works, Reading.

Figs. 10, 11, and 12, represent the side and end elevation of this engine, which is in every respect a most efficient one. Messrs. Barrett's ample stock of machine tools, &c., enable them to turn out everything of first-rate workman-

Fig. 10.—Side elevation.



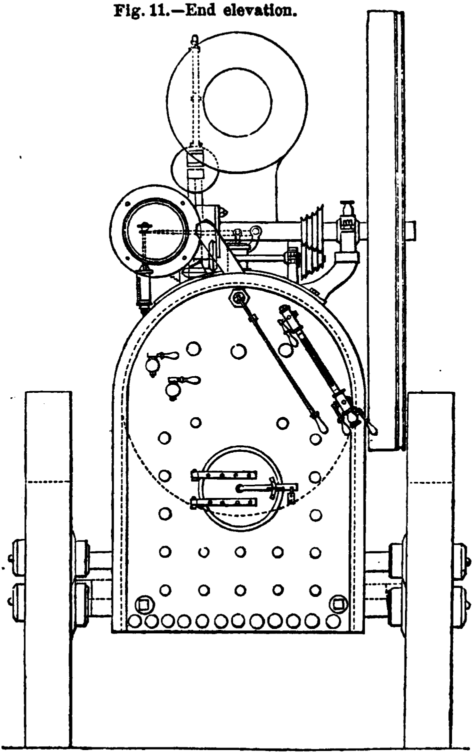
BARRETT, EXALL, AND ANDREWES'S PORTABLE STEAM-ENGINE.

ship, of which their portable steam-engine is a good example. It is constructed in the ordinary manner, with tubular boiler, &c., and the engravings will make it much more clearly understood than any written description. There is one particular point, however, that should be specially observed, and that is, the admirable manner in which the engine is arranged and secured to the boiler. Fig. 12 will show this more clearly. It consists in the engine being complete on a metal frame, independently of its attachment

to the boiler, which renders its removal easy, at any time it may be necessary, without affecting the boiler.

The average consumption (but of course varying with the

Fig. 11.—End elevation.

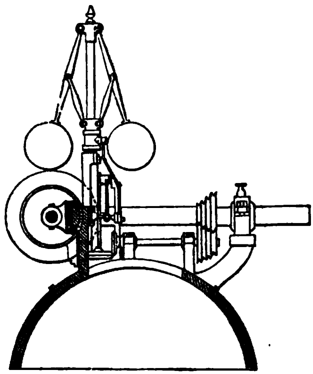


BARRETT, EXALL, AND ANDREWES'S PORTABLE STEAM-ENGINE.

quality of the coal, coke, wood, &c., employed) is found to be about 7lb. per horse-power per hour. The simple arrangement of the parts, and all being exposed to the eye, renders this engine well adapted for agricultural purposes—as a smart agricultural labourer will, with a week's instruction, be better qualified to drive it than

where the engine is out of sight or more complicated in construction.

Fig. 12.—Cross section.



CLAYTON, SHUTTLEWORTH, AND CO.'S ENGINES.

—These makers are justly celebrated for the manufacture of portable engines; they are exceedingly simple, of excellent workmanship, moderate in cost, and consume a very small quantity of fuel; they are well adapted for all the purposes for which steam is used as motive power—as thrashing, grinding, sawing, pumping, or any other purpose. With contractors for works of all kinds they are great favourites.

They are manufactured of various powers, from three horses to ten; in the latter case they are fitted with double cylinders; they are fitted up and equal in workmanship the best locomotives; the engine is well arranged and has an improved governor (which regulates the steam to the greatest nicety), starting-lever, safety-valves (which are acted upon by Salter's spring balance), water and gauge cocks, feed-pump and steam-whistle, all placed within reach of the driver, without his moving from his position in front of the boiler.

The annexed tabular statement will show the results of a trial with eight portable engines, carried out by the judges' direction at the Royal Agricultural Society's meeting, held

at Exeter, 1850, Messrs. Clayton & Shuttleworth's engine being No. 1.

| No. of engine. | Time getting-up steam. | Nominal horse-pwr. | Coals used in getting-up steam. | Coals burnt per hour. | Coals burnt per ho.-pow. per hour. |
|---|---|---|---|---|---|
| | minutes. | | lb. | lb. | lb. |
| 1 | 43 | 7 | 36½ | 54⅓ | 7¾ |
| 2 | 40 | 4 | 52½ | 41⅓ | 9¾ |
| 3 | 105 | 4 | 60 | 112 | 28 |
| 4 | 85 | 6 | 64 | 83 | 13¾ |
| 5 | 39 | 9 | 42 | 68 | 7½ |
| 6 | 81 | 7 | 49¼ | 74 | 10⅓ |
| 7 | 90 | 6 | 44 | 66⅓ | 11 |
| 8 | 34 | 6 | 34 | 62 | 11¼ |

The small three-horse engine, manufactured by this firm, is admirably adapted for small occupiers, and will thrash out, clean and satisfactorily, 20 quarters of wheat per day of ten hours (the crop being of a fair average yield); one horse is sufficient to remove it from place to place when on turnpike roads, and, from its extreme lightness, it may be taken over bad roads and into situations that would not be accessible to engines of greater weight. The consumption of fuel for this engine is 3 cwt. for a day of ten hours; and it will require to be supplied with 270 gals. of water. The seven-horse engine weighs 50 cwt., and consumes, in a day of ten hours, 5 cwt. of coals and 450 gals. of water, and will thrash 35 quarters of mown wheat per day.

The nine-horse power engine weighs 75 cwt., and consumes 9 cwt. of coals, and 800 gals. of water in the day of ten hours.

The last engine is only adapted for farms of the largest description.

I have just seen one of the engines of this firm employed in driving some heavy iron rollers for grinding clay (as heavy a duty as could be laid upon an engine), at the Pottery Works of E. Betts, Esq., on his estate, Preston

Hall, Kent. The driver of the engine gave me a most satisfactory account of it, and seemed well pleased with it in every respect.

*Messrs. Tuxford's Portable Steam-Engines.*—These are considered to be good and effective engines; they are differently constructed to the generality of engines of this description, the ordinary plan being to place the cylinders and engine-work on the top, or nearly so, of the boiler, horizontally, and setting the main shaft across. In Messrs. Tuxford's engine the cylinders are placed in the smoke-box; in this they are thoroughly housed up, and being kept always hot by the draft of hot air through the tubes and by the escape of the steam, a great economy of fuel should take place, as the steam cylinders are as well off in this case as in Messrs. Hornsby's, with the advantage of being accessible at all times by merely opening the moveable plate which forms the back of the smoke-box. The cylinders are set in an upright position, sometimes fixed, and at others they are made to oscillate; there are also peculiarities in the arrangement of the tubes. The fuel consumed is about 4 cwt. per day.

*Messrs. Ransomes' Portable Steam-Engine* is equal in workmanship and effectiveness to any made in England, the object of this firm being to make an engine that shall do the work of agriculturists in a satisfactory manner through a long series of years, instead of making an engine especially with a view to competition at an agricultural show, the results of which must not always be taken as the sole guide in the choice of an engine. The cylinder and the machinery are placed on the top of the boiler; the engine is on the principle we have before alluded to as the trunk engine, the simplest form of engine that can be made; it is fitted with governor, regulator valve, and an efficient feed-pump. The crank-shaft and connecting-rod are of wrought-iron, and the slide-valve is of brass, and of the most improved construction. The steam and escape pipes are of copper, and consequently

not liable to injure the slide-valve and metallic packing of the piston by any scales caused by corrosion of the metal coming off the pipes and being carried by the steam into the working parts of the engines, as is frequently the case in common engines fitted with wrought-iron gas tubes (instead of copper) for steam-pipes. The boiler is made on the same principle as the locomotive boilers, and will work up to 80 lb. pressure on the square inch, should there be any necessity for it. A wrought-iron ash-pan is placed under the fire-box containing water; all hot cinders are immediately extinguished as soon as they fall, thus ensuring the greatest possible safety in working.

Between the engine frame and the axles of the wheels are interposed springs for preserving the machinery from injurious shocks while passing over rough roads. The five-horse engine will thrash, with ease, 40 quarters of wheat (of average yield) per day.

In the Report of the Royal Agricultural Society's meeting at Bristol, 1842, I find that Messrs. Ransomes exhibited a portable disc-engine (tried at Liverpool), but then set upon a carriage with four, instead of two wheels, and having a platform of sufficient dimensions for the conveyance of a thrashing machine from farm to farm. A further alteration had also been effected by applying the power of the engine to give locomotion to the carriage instead of using horses; the engine travelled along a road at the rate of from four to six miles per hour, and was guided and manœuvred so as to fix it in any particular spot with much ease; it turned also in a very small compass; the engine proved itself sufficiently powerful to drive, at full speed, a three-horse thrashing machine. The judges awarded a prize of 30*l.*, but considered it questionable whether the substitution of steam for horses, as the force employed to move portable agricultural engines from place to place, would be found either more convenient or economical; they, however, highly

commended the simplicity and effectiveness of the machinery applied by Messrs. Ransomes to accomplish the purpose. This was in every way a most interesting experiment; but, as it is not now in use, I presume the makers did not find the disc-engine adapted to their purpose.

## CHAPTER III.

### STEAM-BOILERS.

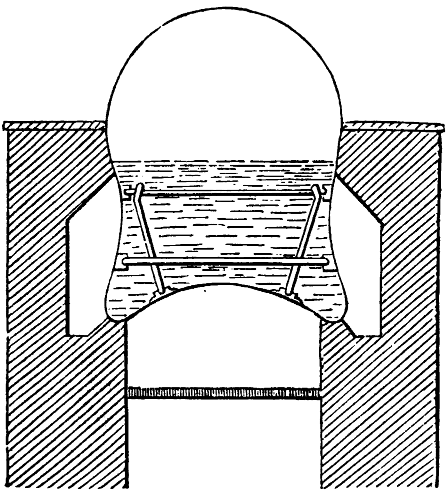
THAT those who employ or are about to employ steam-engines should possess some knowledge of the boilers for the generation of steam to supply these engines, is of the first importance. Farmers will readily understand this when they consider that it is the boilers that will more resemble the horse (whose power, &c. they are about to dispense with) than the engine, for it is this boiler that will consume the coal instead of oats, and whose goodness or badness will render the application of steam power more economical or the reverse; it is the boiler that will require the more special care of its superintendent, and which will soonest show the effects of bad treatment; and it is this same boiler that constitutes all the danger of using steam power, for if an improper one, or a bad one, its owner may be informed of that fact by some terrible explosion. The importance, then, of all those persons using steam, acquiring as much knowledge as they can of the best forms, construction, and most judicious management of steam-boilers, will not for a moment be disputed: we will therefore devote as much space as the limited size of this book will permit, to point out what are the chief points to be attended to in the choice and management of this important machine, and for further information the reader is advised to seek it in Mr. Armstrong's interesting

and valuable little work (one of this series), where he will find the whole matter treated of at considerable length, but in so simple and clear a manner that any workman of ordinary intelligence may understand it.

Steam-boilers, like the engines, are made of an infinite variety of shapes, but such as are adapted for the generation of steam for agricultural engines may be divided into the following classes :—

Low-pressure waggon-boilers, Cornish boilers, boilers with large tubes or flues, and fire-box boilers.

Fig. 13.



SECTION OF WAGGON-BOILER.

Fig. 15 is the vertical section of a waggon-boiler, showing the arrangements for heating and supplying water, with the apparatus called the safety-valve for preventing explosions. Fig. 14 is the transverse section of a boiler of the same kind. This description of boiler is the one most commonly used in factories and mills, where the motive power is a condensing engine. A boiler of this kind 20 feet long, 5 feet wide, and 6 feet 8 inches deep, will supply steam to an engine of

20-horse power, with a very moderate consumption of fuel. They are often made of the same depth and width, but longer or shorter, and each foot is considered as equal to 1-horse power. This description of boiler is always set with what is called a wheel-draft, that is, the current of flame and smoke after passing under the boiler bottom is made to rise up at the back, whence, returning along one side by a brick flue to the front, it crosses the front end, and then passes along the other side to the back, where it goes into

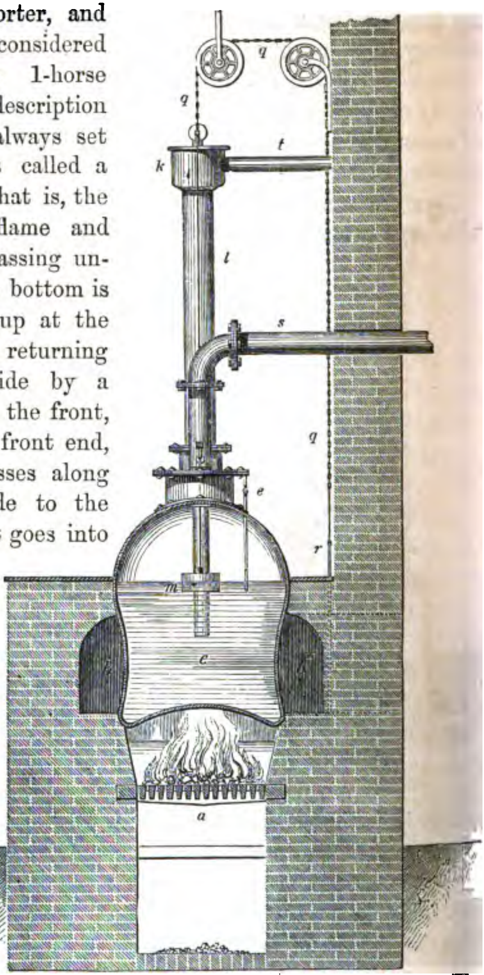
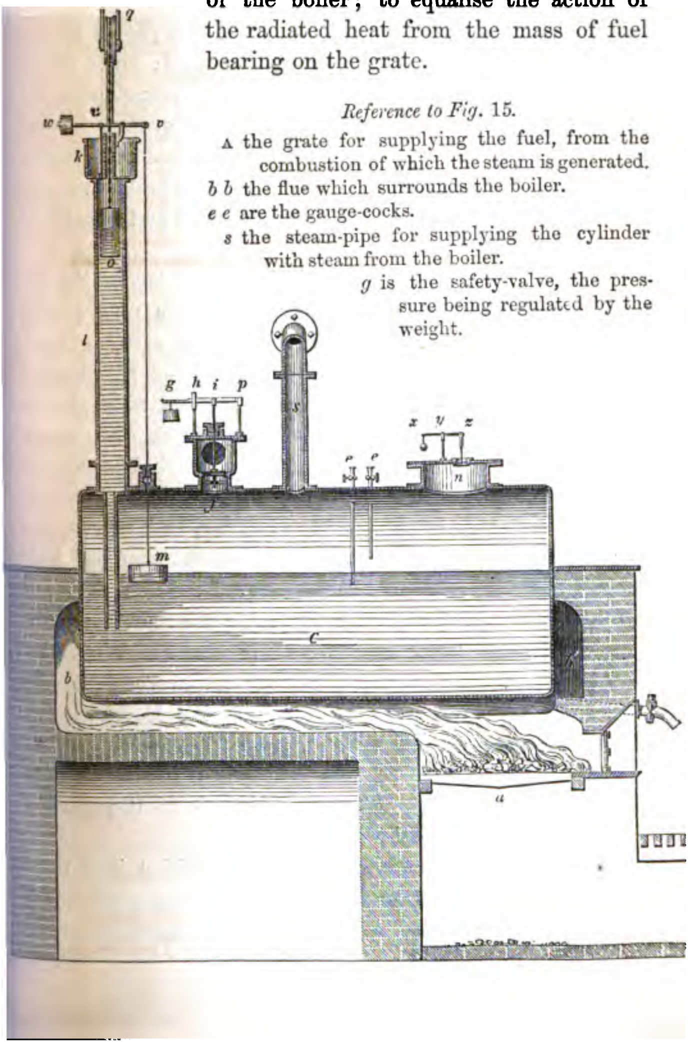



Fig. 14.

the main flue, which conducts it to the chimney. The upper part of the boiler is a semi-cylinder. The lower part

is made with concave sides outwards, 5 or 6 inches on each side, for the purpose of obtaining greater strength for resisting internal pressure. The bottom is arched upwards 10 inches, or 2 inches to each foot of the width of the boiler; to equalise the action of the radiated heat from the mass of fuel bearing on the grate.

Fig. 15.



*Reference to Fig.* 15.

A the grate for supplying the fuel, from the combustion of which the steam is generated.

*b b* the flue which surrounds the boiler.

*e e* are the gauge-cocks.

*s* the steam-pipe for supplying the cylinder with steam from the boiler.

*g* is the safety-valve, the pressure being regulated by the weight.

This description of boiler is well adapted for agricultural purposes, when low-pressure steam is used, as all descriptions of fuel may be burnt under it.

*Flued Boilers* are such as have one or more flues or tubes through them. In these the furnace is placed within the boiler, in the tube, through which the flame passes at once to the chimney shaft, if only one tube is used; but a variety of plans are in use for returning the flame through a number of passages, for the purpose of getting a greater heating surface, and extracting a larger amount of caloric from the fuel; but for agricultural purposes a circular boiler with one tube through is the one most generally used and considered best adapted for such purposes.

*Fire-box Boilers.*—This description of boiler is the one applied to various kinds of portable engines now coming into such general use by agriculturists in every quarter. The inventor of it was the celebrated George Stephenson, and it was first applied to the Rocket Locomotive Engine on the Manchester and Liverpool Railway. It at once superseded all the other descriptions of locomotive boilers then in use. It was examined and its effects witnessed by hundreds of engineers at the opening of the railway, and pronounced by all to be the most important improvement that had been made, and thirty years of trial has proved the fact, for it has not had a single competitor deserving the name; and the more closely the principles involved in that great invention have been adhered to since their great discoverer first made them known, the more perfect has been the locomotive for efficiency and economy combined.

The great principle of this boiler is quick combustion with short and direct draft, the reverse of the Cornish system of slow combustion and long flues.

The fire-box tubular boilers may be divided into three divisions. First, the fire-box in which the combustion of the fuel takes place; secondly, the barrel or tube boiler, in

which are placed the tubes leading the heated air from the fire-box; and thirdly, the smoke or flue box, where the tubes end, and the steam is discharged from the cylinders into the funnel or chimney above, and an intense draft thereby caused through the tubes. Mr. Armstrong considers that increasing the number of these tubes, and the diameter of the boiler, is much preferable to lengthening the tubes and boiler, as I observe some manufacturers of portable farm engines are now doing in imitation of the long boiler railway locomotive. If this is done to the extent I have heard it proposed lately by an eminent manufacturer, his patrons will, I am sure, find them to be anything but portable engines.

Whatever description of boiler is used by the agriculturist should be of as simple a form as possible, one that can be constructed in a sound and perfect manner, that can be kept clean easily, will cost as little money as possible, and that he may rely upon being perfectly safe from accidents.

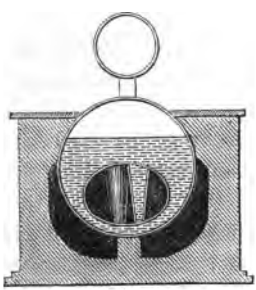
For simplicity, it happens that the best boilers are the most so; for those extraordinary forms of boilers for which patents are so continually being taken out, the farmer should have nothing to do with. The object of these is usually to extract a greater amount of caloric from the fuel. But hear what Mr. Armstrong says of them: "One of the prevalent sources of error to scientific not less than to practical men, is the apparent paradoxical fact that whatever length a boiler is made, the heated air or smoke which escapes is still capable of boiling water in a separate vessel placed in the flue leading to the chimney. This naturally induces a suspicion, that in our ordinary methods of setting boilers we only obtain a small portion of the heat derivable from the fuel."

Hence our patent offices are filled with the thousand-and-one schemes, with their various and endless winding and zigzag flues, of the numerous inventors of boilers, many of whom appear to me to have quite a mania for running after

and using up the whole of the heat, with a determination far exceeding that of the perpetual motion seekers, and with quite as little chance of success. The fact stated, however, is no way surprising: although steam may thus be raised in a close vessel, even to a much greater pressure and temperature than that in a boiler, from which the waste heat has escaped, it certainly must be allowed that steam so obtained, if returned into the boiler at a workable pressure, is *so much* clear gain. My argument, however, only is, that it is *not much*, and calculated commercially it is worth less than nothing, that is, taking time into account; for, according to what is elsewhere stated, we find the steam obtainable in that way to be produced at so slow a rate, that its value is less than a very small per-centage on the capital employed to obtain it.

*Galloway's Patent Double Furnace Tubular Boiler.*—This is a recent improvement in the construction of steam-boilers, and has given the greatest satisfaction. They are a combination of tubular and flue construction: it is the strongest form of boiler, for its dimensions, that has been brought into use, and is the most economic, for its weight, as a generator of steam. Figs. 16, 17, and 18 represent longitudinal and transverse sections of this boiler, showing the mode in which the main flue is supported and strengthened by a series of short vertical tubes, which are made slightly conical, or about two inches wider at the top than the bottom, and amongst which the flame is allowed to play in its passage through the flue; the tubes being plazed zigzag, which gives great facility for this purpose. This arrangement of short water-tubes, to cause them to act as stays of the

Fig. 16.



strongest possible form, and in the best position for resisting any collapse of the fire-flue, is the valuable feature in Messrs. Galloways' invention as regards safety.

In respect to the absorption of heat from the flames, the

Fig. 17.

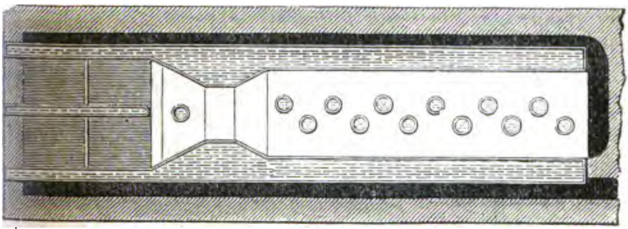
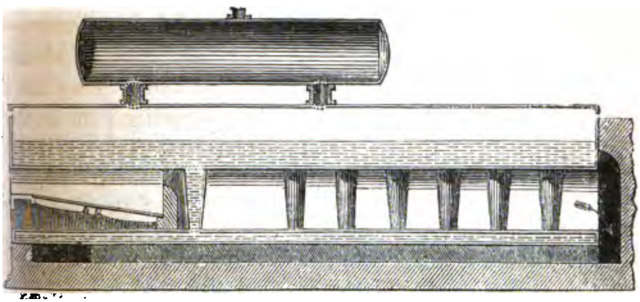


Fig. 18.



disposition of these tubes is also remarkably favourable; for, avoiding the difficulty of causing the flame to make its way through a crowded box full of comparatively small tubes, on the one hand, the tendency of the flame to divide itself into two currents, which a single row of tubes sheltering each would promote, is also prevented; on the other, this arrangement also assists in causing the flame to wrap and envelope the tubes so as to render a greater proportion of their surface effective. Hence this kind of boiler is greatly distinguished for its great economy with flaming fuel, which

is an important point, as that is the most likely to be used in heating boilers for agricultural purposes; for it should be borne in mind that different characteristics are required in a boiler for a non-flaming fuel. The boilers fitted to the agricultural portable engines, containing a number of small tubes, are certainly not so well adapted for flaming as non-flaming fuel, for it is a well known fact that the flame will not enter far into narrow tubes. Mr. Armstrong states that Mr. George Stephenson, the inventor of this description of boiler, expressed to him his opinion that the tubular locomotive boiler, so far as the small tubes are concerned, should be considered merely as an apparatus for *heating with hot air*, and not at all adapted for the use of Newcastle coal; the only object to be obtained in passing the products of combustion through an immense number of small tubes, was (as Mr. Stephenson himself expressed it) to drain out the last dregs of the caloric after the great bulk of the steam is obtained from the action of the flame in the fire-box, on which his chief reliance was placed.

This important point is worthy of the attentive consideration of the constructors of the farmers' portable engines, as the great expense of these engines is the renewal of the tubes and keeping them in repair.

Mr. Galloway's improved boilers may be seen at work at the Gutta Percha Works in the City-road, where they have been found to answer most satisfactorily; they are excellent smoke-consumers, if the two furnaces are fired alternately, and a certain time allowed between each firing, proportioned to the quantity of coal laid on, as the fire from one furnace consumes the smoke of the other, without the necessity of admitting air through any other than the ordinary openings between the bars.

The construction of the boiler, and the necessary strength it should have given to it, must be left to the maker, but it would always be well if the farmer required a written

guarantee when he purchased it that it has been proved to a certain pressure without showing symptoms of any weakness; but the fact of its having been thus tested must not induce those who use it to neglect any precaution for safely working it, for the tensile strain that good wrought-iron is capable of undergoing without rupture is so enormous that it will rarely give way to pressure fairly applied, as it is in the usual manner of testing, yet sometimes they have exploded the first time they have been used after having been so tested.

It is therefore necessary to consider the circumstances under which boilers usually explode, with a view to giving the agriculturist some information as to how he may best avoid similar catastrophes.

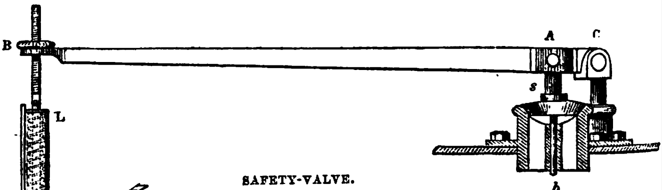
There are only two ways in which a boiler can be caused to explode, or, as it is commonly called, burst. One is by gradually increasing the pressure of the steam in the ordinary manner; it having no means of egress from the boiler it gradually increases until the plates and rivets are no longer able to bear it; a rupture of the weakest part must of course then take place. The other is when, from any cause, so sudden an increase of pressure takes place that the ordinary means provided for its liberation (as the safety-valves, &c.) are unable to act in a sufficiently rapid manner to prevent the strain the boiler is required (though only for a moment) to bear: it is to this last cause that most explosions are due, and the greatest care must be taken to prevent the circumstances arising which produce such terrible disasters. Mr. Armstrong, in the little book I have before alluded to, gives a variety of illustrations of boiler explosions under these and other circumstances, and a perusal of them, with his remarks thereon, would give a better insight into the nature of such accidents than can be acquired in any other way I know of.

The ordinary means adopted to relieve the boiler of

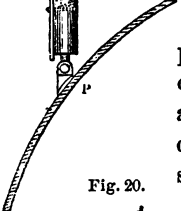
undue pressure is the safety-valve; this is constructed in a variety of ways, but the one most in use for high-pressure agricultural engines is shown in fig. 19, called the spring safety-valve.

The conical valve is represented in its seat; its spindle S being pressed down at A by the lever B A C; C is a fixed

Fig. 19.



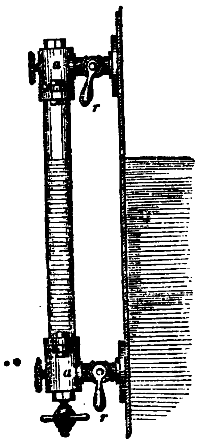
SAFETY-VALVE.



pivot, on which the lever plays; the pressure on the spindle of the valve at A is produced by a nut at B, which presses that end of the lever downwards; the nut works upon a screw, which screw is attached to a spring-balance L, the lower end of which is firmly attached to a fixed point P; the nut B may be turned so as to submit the valve to any pressure within the action of the spring-balance. As the nut is turned, the spring becomes more and more compressed. An index and scale are attached to the balance, the scale being so divided as to show the number of pounds per square inch by which the valve is pressed upon its seat.

There is nothing in the principle of this valve essentially different from the common safety-valve, loaded with a weight usually applied to low pressure boilers; but the quantity of weight in this case that would have to be raised would be inconvenient.

Fig. 20.



WATER-GAUGE.

As shortness of water is a common source of accidents, an apparatus called the water-gauge is used. Fig. 20 represents the glass water-gauge; it is composed of a glass tube with a stop-cock at each end, which communicates with the boiler, the upper one admitting steam and the lower one water; and as the pressure in the tube is the same as in the boiler, the level of the water in the tube will be the same as in the boiler. In tubular boilers, more especially, the gauge requires the constant watching of the fireman.

## CHAPTER IV.

### WATER-POWER.

Of all motive powers the one obtained from a fall of water is the best suited and cheapest for the agriculturist, and if it can possibly be obtained is well worth considerable trouble and first outlay. It is quite true that in this country great care has been taken of every little fall in rivers and streams, and numberless mills have been erected upon them; in fact, too many, for in times past (when land was worth less and a fall of water more) weirs were erected on streams in such a manner as to bay back the water upon the lands of the upper level to such an extent as to much injure their fertility; and in the present day there may be found very extensive districts of flat valleys kept in an unwholesome and swampy state merely to maintain the fall at some trumpery little mill; and it is not only the land immediately abutting upon the upper level of these mill waters, but if the valleys are wide and flat no fall is to be got for neighbouring proprietors to drain their lands, and thus the whole country for miles round is injured. I know many

great flat valleys in this state, and as the efficient drainage of land is now considered as necessary as putting dressings on it, some alteration in the law should take place to enable proprietors to cut drains at a low level, and by the mills, independent of their weirs. The mill-owners would object to this, as they would assert that the drainage of the land was part of their rights, and that they had a vested interest in keeping the valley a swamp. It was so in Walter Blyth's day, 1650, and seems likely to remain so.

If a low drainage level could be got to carry off subterranean water, only allowing the flood waters to go by their natural channels, water-mills might be erected in many situations where they cannot be now, and the drainage-water of the land made available as a motive power for the homestead. This has been done in several cases, and with capital results. In Mr. Williams's pamphlet on land-drainage and irrigation is a most interesting account of a water motive power procured from land drainage, at Teddesley Hay, an estate, belonging to Lord Hatherton, in Staffordshire, from which we quote the following particulars: —"The extent of land which did not require draining was comparatively small, and the whole, which consisted generally of light soil, rather inclined to peat; the subsoil being chiefly clay, has since been subjected to a regular course of thorough draining, and the water collected into two main channels, by which it is first conveyed to an extensive reservoir, which has been constructed for its reception, and from which the water flows underground for a distance of nearly half a mile, in a culvert 15 inches in diameter, to the farm buildings, where it is discharged upon an overshot wheel, and thus furnishes mill power for the various purposes connected with the estate.

"The wheel originally used was constructed of timber, and was 30 feet in diameter; from the want of sufficient natural fall in the surface of the land, between the reservoir

and the farm, no little ingenuity and contrivance were required in the arrangement of the details for using the water in the most efficient manner, and for afterwards getting rid of it. Much talent has been displayed in overcoming these difficulties, which has been done in a way which proves how completely this system of converting the water obtained from the drainage of the land, to the purpose of motive power, is applicable to the great majority of estates of any magnitude in the kingdom.

"The original timber mill-wheel has recently been replaced by one built of wrought-iron, of 38 feet in diameter, which is a model of lightness, combined with strength. This wheel is let into a chase cut into the red sand-stone rock, which here underlies the surface to the depth of its entire height of 38 feet, by which means the upper part of the wheel is brought below the level of the bottom of the reservoir, and a sufficient fall to the water, in its course to the mill, is secured. Having performed its work, the tail water is discharged from the bottom of the wheel, by a head-way, which is driven through the rock, for a distance of some 500 yards, where it is discharged into a lower level of the estate, and made available for the purposes of irrigation to a large extent of upland water meadows. In the recent alterations, iron has been substituted for wood throughout the whole machinery. The extension of the radius of the wheel, would alone have enabled the mill to do more work with the same supply of water; but additional water has also been obtained, and the power of the water-wheel is now equal to twelve horses. A comparatively small portion of the water which is now derived from the drains is required for the purposes of the mill, but being soft, it is all used for the purpose of irrigation.

"The water-wheel works a thrashing-machine, cuts hay and straw, and kibbles oats and barley for a stock consisting of about 250 horses and cattle, grinds wheat and malt, and

drives circular saws, by which the saving of all the smaller scantlings for the use of the estate is executed."

Although advocating the setting up of water-wheels, there are certain drawbacks that must not be lost sight of, such as the great cost of constructing the works for storing the water for supplying the wheel, and for carrying it clear of the mill-tail when done with, as well as its affecting the position of the steading, which should certainly not be placed in an unhealthy place for the sake of the water-wheel; but running water is in no way unhealthy, and if the ground about the steading be properly drained into the mill-tail, there is no fear of injury accruing from such source: nevertheless, it is often the case that *water power is paid too dearly for*.

Water-wheels are of three kinds, and severally called overshot, breast, undershot, and horizontal wheels, or turbines.

*The overshot wheel* is the most powerful form of wheel, as in this case the whole fall of the water, being something greater than the diameter of the wheel, is employed in producing the power which in some cases, where the machinery is of superior description, is as much as 75 per cent. of the actual fall of the water.

The overshot is best adapted for small streams of considerable fall; and the breast-wheel for large streams with a small fall; while the undershot, or sweepshot, as it is often called by millwrights, is chiefly used as a flood wheel, or for obtaining motive power from the ebb and flow of the tide. For a description of the manner of constructing water-wheels, turbines, &c., see Mr. Glyn's work, in this series, upon mill-work.

Water-wheels are now generally constructed of iron, and it is by far the best material; in some cases a ring of cogs is placed upon the shrouding of the wheel, and thus the speed is got up at once without the intervention of intermediate gear.

The water is supplied to the wheel from a trough or shoot, the bottom surface of which should be about 0·4 of a foot from the crown of the wheel, to allow of the water obtaining a little greater velocity than the outer edge of the wheel. On some wheels the water is admitted a little below the crown; the wheel is made in this case of a greater diameter than the depth of the fall. This plan is preferred by many old millwrights, and they assert that, in practice, it has advantages over the other plan: it is called by them bastard overshot. The width of the trough should be something less than the wheel, to prevent waste, and allow for the escape of the air from out of the buckets.

The gate, or shuttle, should be neatly constructed, and work truly and easily, which it very seldom will be found to do unless some extra pains be taken in fitting it. A winch inside the mill (working a shaft upon which are two pinions, gearing into two racks attached to the gate) is the general method employed to supply the water to the wheel.

All the works erected or made in connection with water-wheels should be done with great care, and be very accurately set out, to prevent leakage and waste; all the brickwork should be done with well-burnt bricks, set in good Roman cement, and efficient walling be placed at the junction with the banks that form the pound or head and the walls of the mill,—for unless these points be well attended to, the water will find its way to the back of the works, and in a short time make passages through to the mill-tail: when this is the case, a large outlay will soon have to be made for repairs.

In all cases, efficient hatches must be constructed for drawing off the head of water. For a description of the manner of constructing hatches, see Part III. of this work.

A properly-constructed weir should also be provided, the upper sill to be the maximum level of the head of water.

## CHAPTER V.

### WINDMILLS.

These machines have been used in Scotland for many years as motive power, but not with such results as to justify their being erected, unless in particular situations.

Windmills are exceedingly expensive in their first construction, and in their maintenance afterwards. They are exceedingly uncertain and irregular in their action, and the farmer finds himself entirely at the mercy of the wind as to whether he shall have his corn to market at the time he thinks fit or not. They are now fast disappearing from the face of the country, where they have been well tried, and therefore may be considered as quite inapplicable.

These objections do not apply to the use of windmills for unwatering land, as there are, no doubt, situations where these machines may be well applied, for driving scoop-wheels, &c., as is done all over Holland. For a description of these mills, and the manner of constructing them, see Part III. of this work, on field engines and implements.

## CHAPTER VI.

### HORSE-GEAR.

The employment of horses for working large mills is not now nearly so common as formerly, for, if four or six horses' power is required, it is much more economical to employ a steam-engine.

Very expensive horse-wheels were formerly constructed of a substantial and durable character, and fixed in an appropriate building. These are never now erected, a portable description having taken their places, and are now usually employed to drive thrashing-machines, &c.

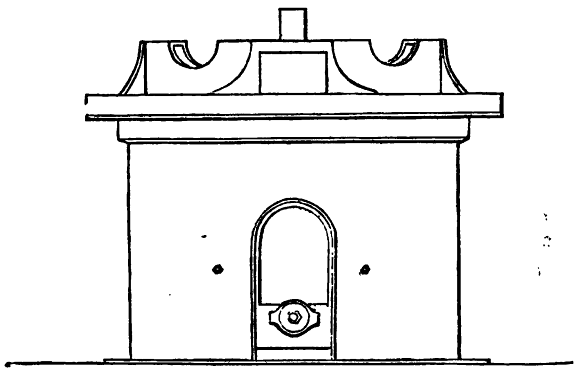
For turning edge stones, as in cyder-mills, &c., the fixed wheel may sometimes now be met with. They are of two kinds, the overhead and the underfoot wheels. The diameter of them is often made equal to the entire diameter of the horse-walk, and toothed on its outer edge. The speed is at once got up by this means, but it is exceedingly irregular in its action, and is a dead pull for the horse, there being no intermediate parts to equalise the strain by their elasticity, which is necessary to animal labour. The manner of yoking horses when employed in this way is of considerable importance, as the horse is always exerting himself in a direction tangential to the circle of his walk; the animal, therefore, should draw by a swing-tree, instead of a yoke, attached to a beam overhead. In the case of one horse hanging back and leaving the others to do his work, an arrangement has been made which effectually prevents it. It was invented by Mr. Christie, of Fifeshire, and is described in the Transactions of the Highland Agricultural Society. The principle of the arrangement is, that the ring-chain forms a figure of as many equal sides or angles as there are horses in the wheel, and that the angles shall always remain equal; by this means every horse is compelled to bear his fair share of the load.

The horse-work in common use consists of radiating bars, to which the horses are fastened, attached to an upright shaft, which works a series of wheels by which the speed is got up, and conveyed to the machine by a shaft laid horizontally and attached to another shaft by a very favourite contrivance with agricultural machinists, called a universal joint. The horses have to step or stumble over

this connecting shaft in passing round. To save their heels, some litter and a board are placed over the shaft; but the whole thing is as clumsy a concern as it is possible to find, and should never be used unless in temporary situations, as thrashing in the field, &c. If horses are employed regularly to do the work of the steading, a neat and proper machine should be constructed, with the shaft underground and an intermediate motion to carry it to the machines.

A great improvement has been made by Messrs. Barrett, Exall, & Andrewes, in the construction of the horse-work.

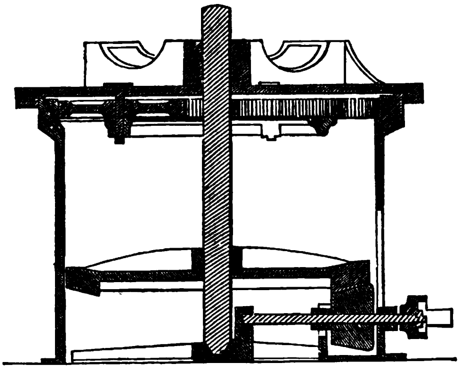
Fig. 21.—Elevation.



Figs. 21, 22, and 23 are an elevation, section, and plan of this machine. Its action is thus: on the inner edge of the cylinder are a set of cogs, which work into three loose wheels, and communicate the motion to a pinion on an upright shaft in the centre, on the bottom of this is fastened a bevel wheel working into a pinion, which communicates the power to the outside, giving 33 revolutions for each circuit of the horse, so that if the horse travels round three times in a minute, 99 revolutions are given per minute to the lay shaft.

The whole of the machinery is enclosed in a cast-iron cylinder, with a moveable cap revolving (when at work) on

Fig. 22.—Section.



its upper surface. Nothing can gain admittance into the cylinder unless purposely placed there.

Fig. 23.—Plan.

## CHAPTER VII.

### THE THRASHING-MACHINE.

After the anxious and arduous operations of growing and harvesting, the grain crops have been gone through, the next thing requiring the farmer's attention is preparing that grain for market and use, by separating it from the straw and chaff. The first of these processes is now effected either by the flail or the thrashing-machine. Although these two implements are now the only ones in use, it may not be out of place here to glance at the various methods adopted in ancient and more modern times for effecting these purposes.

The earliest method known or recorded for extracting the grain from the straw, is that sculptured upon the Egyptian monuments, in which the straw was laid in a circle, and oxen were driven round upon it, who, by the action of their feet rubbed out the grain.

This is the plan alluded to in the Old Testament, where it is written, "Thou shalt not muzzle the ox that treadeth out the corn."

Other passages in Scripture also allude to different plans, as in Isaiah, xxviii. 28—"Bread-corn is bruised; because he will not ever be threshing it, nor break it with the wheel of his cart, nor bruise it with his horsemen."

But there is no doubt that the flail and thrashing-floor, something similar to that in present use, was known to, and used by the Jews, as in the same chapter, 27th verse,—"For the fitches are not threshed with a threshing instrument, neither is a cart-wheel turned about upon the cummin; but the fitches are beaten out with a staff, and the cummin with a rod." The flail was also used, as well as other plans, by the Romans, and frequent mention is made of the thrashing-

floor, its situation, and manner of construction, by Columella, Varro, and other writers, and it is from that enlightened people, that the early inhabitants of these islands were first made acquainted with these and other operations connected with husbandry.

The flail continued to be the chief implement used for thrashing in England, until about the year 1732, when mention is made of a machine for thrashing, invented by Mr. Michael Menzies, which is thus described in the "Gentleman's Magazine," 1751:—

"A gentleman at Dalkeith, Edinburgh, in Scotland, has invented a machine for thrashing grain, which in a minute gives 1320 strokes, as many as 33 men thrashing briskly. But as men rest sometimes, and the machine never stops, it will give more strokes in a day than 40 men by common supples, and with as much strength. It does not take more room than two men thrashing, but gets 6 per cent., or one peck, more in a boll, out of the straw, than in the common way. It goes while a water-mill is grinding, but may be turned by wind or horse. The inventor has a patent, and can make them of smaller sizes, to do the work of eight or ten men."

Notwithstanding this laudatory description, the machine never came into general use, and the reason given by Mr. Robert Brown, in speaking of it, is, that the flails of which it was composed were very soon destroyed from the velocity at which it was necessary to drive it; and it seems that the only benefit derived from the implement was that it caused public attention to be directed to the subject, and in the end a more perfect machine was the result.

During the next twenty years, various attempts were made to construct a thrashing-machine. One of the most prominent was invented by Mr. Michael Stirling, a farmer at Dumblane, Perthshire, described as something like a flax-dressing mill, the corn being let down into a cylinder, in

which were arms or beaters, turning upon a vertical shaft, running at a high velocity. The grain was beaten out by these arms, and passing through the floor, left the straw behind. Another, in 1772, by two gentlemen of Alnwick, Northumberland, named Ilderton and Smart. In this, the sheaves were carried round between an indented drum and a number of fluted rollers, which, pressing by means of springs against the drum, rubbed out the grain. Another, in 1785, was invented by one William Winlaw, of London. This machine is described by Mr. Ransome, in his book of the Implements of Agriculture, as being made on a principle similar to a common coffee-mill. This machine, he observes, effected another object, not described in the specification, and one which the inventor hardly contemplated—for it *ground* the corn as well as thrashed it.

In 1792 another machine was made, somewhat similar to the one originally constructed by Menzies. In this, a number of loose flails were made to act upon a grated floor, the straw being presented to the action of the flails by hand. In 1795 one Jubb, of Lewes, obtained a patent for another machine, with revolving beaters, the straw being held in its place by feeding rollers.

Not one of these machines came into general use, and they are now mere matters of history.

### MEIKLE'S THRASHING-MACHINE.

During the latter part of this time, the attention of a most ingenious mechanic had been directed to the construction of a thrashing-machine. His name was Andrew Meikle, millwright, of Houston Mill, Tyningham, East Lothian. Sir Francis Kinloch, Bart., of Gilmerton, had a thrashing-machine constructed, which he sent to Meikle to try some experiments with. It however did not succeed; and Meikle, after various attempts to improve upon it, abandoned it as hopeless. He next set about constructing

another, upon a totally different plan, and, in 1786, produced the first really useful thrashing-machine; and the principle of this has been the basis upon which all other machines, up to the present time, have been constructed. The mode he adopted was that of introducing between two rollers the corn, which was then acted upon by four beaters fixed upon a revolving drum, these rollers striking as they revolved. The machine was found to answer so well, that an immediate application was made to secure the invention by patent, which was obtained after some slight opposition. In Mr. Ransome's book are copies of the original drawings accompanying the specification, and are, as he observes, exceedingly interesting, as showing how comparatively successful was this early design for the full accomplishment of the purpose intended.

Between the time of constructing the first machine and the completion of the patent, a most important improvement was made in the form of the beater, by substituting a sharp edge in place of the original flat-faced bar, by which means the grain was scutched instead of being beaten out. Mr. Ransome illustrates this difference of principle, by supposing a handful of straw, with the corn in the ear, to be held in the hand, while, with the flat side of a thin piece of wood, the ears should be struck or beaten. This is the operation of the common beater. If, instead of striking the corn with the flat side, a sharp blow be given with the thin edge, in the direction of the ear, it will strip the corn from such parts as the edge touches with less labour and with greater certainty.

The merits of Mr. Meikle's machine having been now satisfactorily proved, its fame spread abroad, and, as might be expected, it was soon imitated by other millwrights, some of whom claimed to be the inventors of it. Still it did not, for the first ten years, come much into use, nor did the inventor reap any great benefit from it. It is, however,

satisfactory to know, on the authority of Mr. Robert Brown, that a society of gentlemen, headed by Sir John Sinclair, raised a fund sufficient to render his declining years comfortable, and enable him to provide for his family.

Professor Low says, "To Andrew Meikle belongs the honour of having invented the first thrashing-machine. Changes and improvements have indeed been made in certain parts of the original machine, but in all its essential parts, and in the principle of its construction, it remains as it came from the hands of the inventor."

Thrashing-machines upon Meikle's principle are now common in Scotland, and few large farms are without one. These thrashing-machines, or thrashing-mills, as they are generally called, are regularly constructed works, permanently fixed, and are very expensive in their first cost. A few have been erected in England upon the example farms of noblemen, as at Holkham, Whitfield, and other places; but they cannot be said to be in general use. The machine used in England is simply a thrashing-machine, and is generally portable, while the Scotch machine is always fixed, and has winnowing apparatus attached: it is much clumsier in construction, and though acting upon the grain by beaters placed on a drum parallel to its axis, yet the principle of forcing the grain from the husk is quite different. In the Scotch machines, the grain being held fast between rollers is subjected to the action of the revolving beaters, and the corn scutched or beaten out, the concave or breasting having little to do with it; while in the English machines the breasting plays the most important part, the grain being rubbed out instead of being beaten out during its passage between the concave and the cylinder, which is driven at a much higher velocity in the English machines than in the Scotch. One great difference in the action of the machines is, that in the Scotch the beaters strike upwards in nearly all cases: in England it is the

reverse; the corn never is sufficiently long subjected to the action of the beaters in consequence. The feeding rollers are generally made fluted or indented longitudinally in some way, as they are when smooth very liable to clog by the straw wrapping itself round them, should it be in a damp state. They are usually about four inches in diameter, and wider than the drum, and made of cast-iron. They are worked by gear attached to part of the machine in motion, and require to have their speed regulated according to the description and condition of the material they are working with.

The cylinder is made a close drum with the beaters as projections upon it; in the English machines it is nearly always open. The diameter of the drum is generally about 3 feet, and varies in width from 2 feet 6 inches to 4 feet and even 5 feet; about 3 feet 6 inches is the ordinary dimension.

Attached to the machine for thrashing is an apparatus for shaking the straw; this is generally formed of another large close cylinder, having tines or spikes projecting from it; generally two of these shakers are attached to each machine; they revolve much slower than the thrashing-drum, and are driven with cog-gear. The whole is fitted up in one large case, and is generally placed upon an elevated stage, or upper floor of the barn, to allow of the blowing, winnowing, or cleaning machinery being arranged beneath it; there are several other contrivances for effecting different objects, such as lifting the sheaves to the feed-rollers and raising the corn, after it has been thrashed out from the husk, to the hoppers of the cleaning machine.

One of the best and most complete thrashing-machines erected is at Whitfield, and the following description I have extracted from Mr. Ransome's book (The Implements of Agriculture), where the early contrivances and the progress of the thrashing-machine are treated at great length, and

some interesting cuts inserted of the earliest attempts to construct this important machine:—

"This machine is worked by a steam-engine of six-horse power. The corn is brought from the stack upon waggons, running along a tram-road upon an inclined plane, to the doors of the building, whence, sheaf by sheaf, it is thrown by children into the buckets of an elevator, which, in its rotation, carries them to the feeding-board. This feeding-board is placed at a tangent from the drum parallel with its top; and, as in Lee's machine, and the portable machines in Suffolk and Norfolk, the feeding-rollers are dispensed with; an endless web gradually carries the unthrashed straw to the feeding mouth, from which the revolving scutchers rapidly convey it to the concave. The drum is about 18 inches diameter, formed of sheet-iron strained round a cast-iron skeleton, accurately turned. Upon this the beaters, or rather scutchers, formed of angle iron with its edges planed, are so placed as to describe an angle with the surface of the drum, pointing forward in the direction of its motion; these project about $\frac{7}{8}$ of an inch. The screen, or concave, incloses the drum to the extent of about $\frac{1}{3}$ of its circumference, and consists of four or five arched pieces of grating, 3 inches wide, joined together. It is made of cast-iron bars, having a square section placed so that every one shall present an edge to the passage of the straw, uniting (as it is not uncommon in other machines) the fluted concave of the Scotch machine with the wired grating of the English ones. The screen is supported on iron bolts, so that it approaches to within about $\frac{1}{8}$ of an inch of the edge of the scutcher. Spiral springs surround these bolts, which permit the bars of the concave to yield when too much pressure may at any time occur between them and the revolving drum. The grain is thus separated, most of it passing through the screen of the concave; but in order that no grain shall be allowed to pass away with the straw,

it is thrown upon the shaker below. This is a moveable harp or screen, and is made of spars $\frac{3}{4}$ of an inch from one another, 2 inches deep, $\frac{3}{4}$ of an inch wide, and 6 feet long; they are thirty in number, and are thus arranged over a width of 3 feet 9 inches. These spars are fixed to two pair of frames—the odd, 1, 3, 5, &c., being attached to one pair, and the even numbers, 2, 4, 6, to the other pair. These frames are supported by two iron shafts, each having two cranks projecting $3\frac{1}{2}$ inches on each side of them; the frames are attached to these cranks by arms with brasses, in which the cranks revolve; the shafts are connected together by a rod, so that they both move at the same time. In the revolution of the cranks, everything attached to them also revolves; so that each point of the arms, frames, and spars revolves about a centre belonging to itself only; at the same time, the regularity in the length of the crank, and the uniform motion of the two shafts, has the effect of keeping the frames always parallel; their position at any one point being parallel to their position at any other. The blows occasioned, as each series of spars strike the straw from beneath, effectively remove every particle of loose grain, while the shaker rapidly carries forward the straw, and at its termination deposits it in the straw-house, while the corn, sifted out by its action, falls before the blast of a fanner; and all the light grain and short straws, thrown out by the first winnowing into the light corn spout, is then taken up by another elevator, deposited again upon the feeding-board, and passed a second time through the drum, in order effectually to separate any that may remain. After passing through another winnower, the thoroughly cleaned corn is taken up by a third elevator and dropped into a hopper, through which it passes into a sack, which is placed on a weighing machine, and it is there weighed and left thoroughly fit for market."

The English thrashing-machine, as we have before observed,

is simply a machine to separate the kernels of the corn from the husks; it is therefore smaller and much cheaper; and as the large fixed machine will never make a sufficiently clean sample of wheat for market, the English farmers prefer performing all the operations of cleaning entirely separate from the thrashing process.

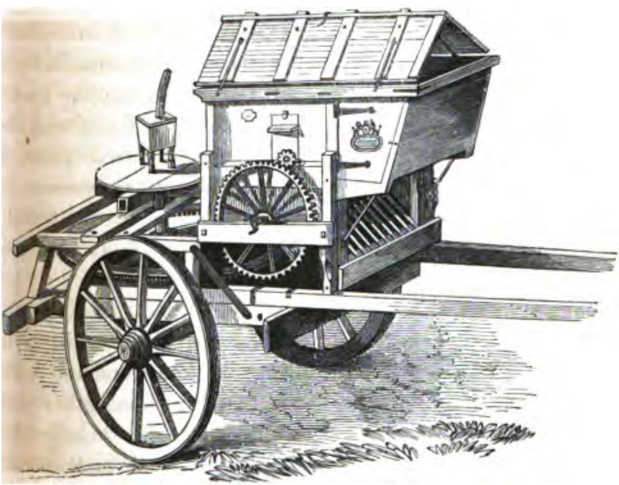
The original inventor of the English machine seems to have been H. P. Lee, Esq., of Maidenhead Thicket; for he first got rid of the cumbrous feeding-rollers and arranged the concave as it is now used. The English machine now in use consists of a cylinder with five or six beaters attached on arms which radiate from the centre. These beaters are variously formed by different makers; sometimes they are square bars of wood faced with iron plates; at another they are circular iron rods, or semicircular bars striking with their sharp edges, and in one class of machines they are bars with serrated or notched faces. These beaters, scutchers, or rubbers—for they combine the three operations, in their passage by the concave—force out the grain from the husks. The concave, or screen, surrounds the drum for about the third part of its circumference; it, like the beaters, is formed in a variety of ways, but generally consists of a series of ribs, between which is placed a wire grating; the front of the ribs is generally covered with a plate of cast-iron having a fluted or grooved face. The straw is fed over a feeding-board, the heads foremost into the space between the concave and the breasting, and drawn through by the revolving cylinder. The space between the concave and the drum is adjusted by means of two screws; it is usual to set the opening at the feed about an inch and a half, and decrease it to about an inch where the straw is delivered. A harp, or screen, is placed here, through which the corn falls, and the straw is removed with forks.

Machines upon this principle, with slight modifications, are now made by all the large manufacturers, and an

important addition has lately been made for shaking the straw after it leaves the cylinder; this principle is applied to the machines manufactured by Mr. Garrett, and is shown in Fig. 26. Messrs. Hornsby also construct it, and Messrs. Clayton & Shuttleworth manufacture a most efficient machine, of which they have favoured me with the following description:—

"The chief novelty in this machine is the (registered) vibrating trough, which is suspended by four links, and extends the whole length of the machine and straw-shaker, and has a reciprocating motion given to it by means of a crank. The great quantity of pulse, or colder, which drops through the bars of the straw-shaker, has long been considered very objectionable, inasmuch as it increases consider-

Fig. 24.



GARRETT'S THRASHING-MACHINE PACKED FOR TRAVELLING.

ably the amount of labour in the barn, both at the time of thrashing, and also when going through the dressing-machine.

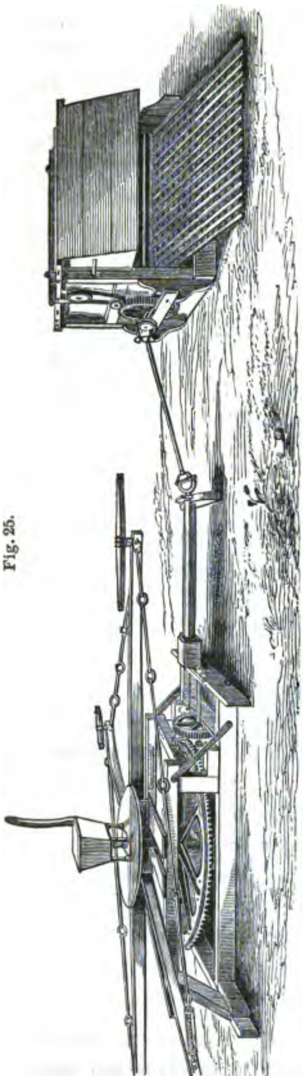


Fig. 25.

GARRETT'S THRASHING-MACHINE AND HORSE-GEAR.

But, by means of the vibrating trough, the whole, as it drops from the thrashing-drum and straw-shaker, is caught and passed over a riddle; under which the blast is directed, thereby effectually separating the corn, chaff, and pulse from each other, each being discharged into the places assigned for them, thus effecting a considerable saving in manual labour."

As the English farm steadings are at present generally without fixed motive power, the thrashing-machine is usually constructed in a portable form, and is made to pack up neatly with the horse work, and can so be removed from place to place. Fig. 24 represents the machine as packed for travelling, and Fig. 25 as arranged for work in the field.

Straw that has passed through a machine is, from being broken, rendered unfit for thatching and other purposes. A machine therefore has been introduced for thrashing the straw lengthways, and is called a bolting machine. I am not aware who was the first inventor of it; I believe it was

the Messrs. Garrett. I find the following notice of one introduced to the Royal Agricultural Society by Messrs. Ransomes & May, at the Derby Meeting in 1843 :—

"A wheat thrashing-machine, by Messrs. Ransome, was distinguished by some novelties which deserve notice. It was driven by the horse-engine previously referred to as having the connecting shaft over head; its chief characteristics consist in an arrangement of the beaters, so that they are fed with the straw and ears in a horizontal, instead of a vertical direction, by which means the straw is delivered flat, straight, and unbroken. Thus the straw, after being thrashed, issues in a state ready for immediate tying up. The machine is also furnished with a contrivance for conveying and shaking the straw. The judges cannot but highly commend Messrs. Ransome's efforts and ingenuity in perfecting a species of thrashing-machine more particularly coveted by farmers residing near large towns, to whom the production of clean unbroken straw is frequently an object of more importance than the thrashing out the greatest possible quantity of grain in a given time."

Fig. 26 represents a section of what may be considered one of the best specimens of the English thrashing-machine, all the most recent improvements being applied to it. It is manufactured by Messrs. Garrett, of Leiston Works, near Saxmundham, Suffolk, who have devoted the greatest possible attention to the improving this important machine. The form of the beaters and the concave is peculiar; and is the result of repeated trials and experiments.

*Reference to Plate.*

A Drum, of improved construction, which performs the operation of thrashing.

B Concave or breastwork surrounding the drum, adjusted by the regulating irons, *b b b*.

C Straw-shaker, which receives the straw from the drum of the machine, and shakes out all loose kernels that may be amongst it.

D Screen vibrating on the rods, *d d*, the corn, chaff, &c., being conducted from the concave and shaker; it is for the purpose of separating the loose ears, short straws, cavings, &c., from amongst the corn and light chaff.

E Blast fan, for winnowing the light chaff from the corn, while the corn is passing over the screen, D.

F An apartment for the corn after it has gone through the various processes above described; it is delivered free from all chaff or rubbish. If the thrashing apparatus is fixed in a building, the corn may be conducted from this receptacle to the dressing machine, *once* passing through the sieves of which will render it fit for market.

Fig. 26.—Section.


GARRETT'S IMPROVED THRASHING-MACHINE AND STRAW-SHAKER.

One of the great defects in the thrashing-machine is the difficulty of adjusting the concave or breasting to the different widths of opening necessary for the different

descriptions of grain to be thrashed; as it is evident that drawing the one circle from without the other will leave a space greater in the middle than at either end. The breasting is generally made in two pieces, and adjusted with screws, to accommodate itself, as nearly as possible, to the drum; but it is then in anything but a perfect state; and bad thrashing is generally the result of too much meddling with these screws, when the machine is in the hands of the ordinary farm labourer.

Messrs. Barrett, Exall, and Andrewes are the patentees of an improved thrashing-machine, in which this difficulty is got rid of in a most ingenious manner, by the introduction of a wrought-iron concave, or breasting, formed of separate bars, with grooved faces, working through slots in the side of the machine, and brought nearer to, or carried further from, the drum, by means of two circles. These work round its centre, with a continuous grooved worm cut on their faces, in which the breasting-bars move. This arrangement allows the bars to separate wider from each other, as well as more distant from the drum; and thus gives the larger corn, beans, peas, &c., a wider space to escape when thrashed.

Messrs. Hensman's improvements are thus described by them in their catalogue: (I have had no personal experience with Hensman's machines, but I know from report that they are thought very highly of by those who use them;)—

"One great feature of importance in the construction of these machines, and which makes them of the utmost value to agriculturists, is, the outer edges of the beaters, or thrashing cylinder, being of a vandyke or tooth shape, which revolve between similar notches in the concave; and is found to search the straw so perfectly, as to get out all the grain, without injuring either corn or straw more than flail-thrashing. They will also thrash with the concave, at a great distance from the drum, whereby the draught of the

horses is much diminished; in addition to which they are so arranged that the horses do not require to be driven faster than the usual ploughing pace, as over-driving is always found to distress farm horses more than the draught of the machine.

"By the use of these machines, the evils so long complained of in barley-thrashing on the old principle, are entirely dispensed with: viz., those of passing it through the machine twice, and of injuring it for malting. They are warranted to thrash barley, and all other grain, perfectly clean, at one operation; the process being more like rubbing or stripping than beating the corn. The necessary speed of the drum is procured by three motions, instead of two only, as was formerly the plan: and this alteration, with other improvements throughout, has added considerably to the ease of working, and much diminished the wear and tear of the machine."

## CHAPTER VIII.

### WINNOWING MACHINES.—HUMMELING MACHINES.—SMUT MACHINE.—SEED SEPARATING MACHINE.

### THE WINNOWING-MACHINE.

After the grains of corn have been forced from the husks by the action of the beaters of the thrashing-machine, or the flail, it is necessary to separate them from the hulls, chaff, or caving, as it is variously called, as well as from all small seeds, little stones, dirt, and other matter, that shall take from the cleanliness of the sample. This is effected by the operation called winnowing.

In the earlier ages this was performed by merely lifting the corn and chaff in long narrow shovels, and against the

direction of the wind. The chaff, being so much lighter, was by this means, in its passage from the shovels to the ground, blown a considerable distance from the wheat, and an imperfect separation took place. An immense variety of contrivances are alluded to in Scripture, and in classic writings, as being employed to separate the chaff from the corn. Sieves are often alluded to, and fans, from which it may be presumed that an artificial draft was early obtained, as it would be exceedingly inconvenient to be waiting for a natural wind. Roman writers, however, speak of waiting for the wind; and Columella describes how the corn should be heaped, that it may not injure from lying on the floor. He also alludes to the using of fans, should no wind blow, from which I judge his fanning apparatus to be so inconvenient and ineffective, that it was only used in cases of sheer necessity. He also remarks on the danger of waiting, lest when the wind does come, it may be a storm, and blow corn and chaff away together.

Sieves were used to give the corn a second dressing, after the chaff had been removed, and to take out stones, dirt, &c. Common fans are used now in various parts of Asia, with a sieve for cleaning corn.

Mr. Ritchie describes the manner of winnowing in the western highlands of Scotland as being in a most primitive state:—"The grain is winnowed by a fan or shovel, which is made of sheepskin, stretched on a wooden hoop or circle, about two inches deep. Two sieves or riddles are also used; the one perforated with large and the other with small holes. The Highland barns are of the most simple and antique description. The barn has two doors, which, during the operation are left open; and the person who winnows stands in the middle between the two doors, lifts the grain in the fan, holds it in both hands, shakes it slightly with one hand, and the grain drops gently, while the husks are carried away by the current of wind entering at one door

and blowing out at the other. This has been until lately the ordinary manner of winnowing all over England; the only difference being in the form of fan; the one in general use in England being made of two upright supports, with a notch in the top, in which rested a horizontal shaft. Upon this shaft was placed four bars of wood parallel with it, and about fifteen inches from it: the connection being formed with wooden arms. On the outer edge of these bars is fastened a piece of cloth by one edge only. This reel or fanner is placed on the wooden supports, and turned by a winch fixed at one end, the pieces of cloth flying out from the bars, and as the machine revolves, a considerable current of air is produced. This machine will be found in many old farmeries at this day.

The first regular winnowing-machine used either in England or Scotland was introduced from Holland, by Andrew Fletcher of Saltoun.

The Dutch had no doubt previously obtained the idea from the East Indies, as a machine for driving off chaff and dust was invented and applied by the Chinese to the cleaning of rice. In Holland this machine is attached to mills for making pot or pearl barley.

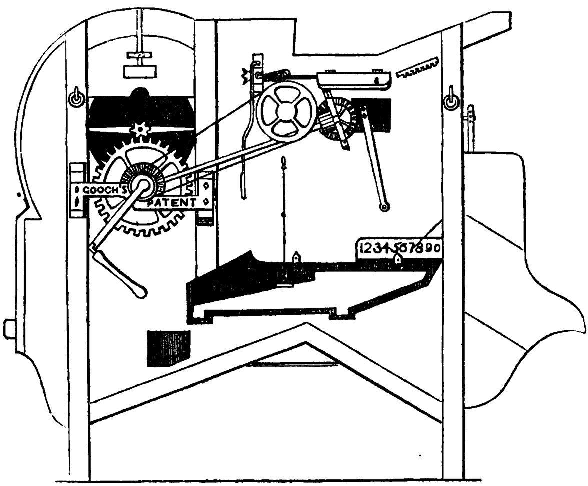
James Meikle, father to Meikle who invented the thrashing-machine, was sent to Holland by the Laird of Saltoun to learn the art of sheeling barley, in order to effect the introduction of the barley-mill.

On Meikle's return he made the first fanners ever seen in Great Britain for the Saltoun Barley Mills. Meikle was bound in his agreement with the laird not to communicate the art he had learned to any other, nor to make any profit of it after leaving the laird's service.

A large and improved form of this machine, applicable to the cleaning all sorts of grain, began to be manufactured about 1733, by Rogers, of Cavers, Roxburghshire. These machines, though greatly preferable to the old methods of

dressing by hand, were still in a rude state, and the corn required to be passed two or three times through the machine before it was a clean marketable sample. In 1768 other improvements were added, and a patent taken out by A. R. Meikle. Moodie, of Lilliesheaf, seems to have been the inventor of the first machine that would at one operation separate the grain from the chaff and lighter seeds, and completely riddle it of all sorts of refuse; Mr. Gooch, of Northampton, in the year 1800, patented a highly improved machine (upon which are based all the winnowing-machines at present in use).

Fig. 27.




GOOCH'S PATENT WINNOWING-MACHINE.

This machine, invented in 1800, gained a prize in 1841 from the Royal Agricultural Society, and his machine is at the present time considered one of the very best in use.

The principle upon which the modern improved winnowing-

machines act is this: a strong current of wind is driven (by means of a revolving fan) through an inclined tunnel; above this tunnel is a hopper, having a sluice gate, through which the corn is allowed to pass in any given quantity. The bottom of the tunnel is formed of wire sieves of different degrees of fineness, each division of wire having a receptacle below; beneath the hopper is placed a frame, which contains one or two sieves, and is called the riddle frame; one end of this frame is attached to the bottom of the hopper, and the other is supported by a chain or other contrivance, allowing of its being moved with a peculiar jerking motion by a crank which passes through the side of the machine, and is worked by a small connecting-rod from the shaft, upon which the blower is hung.

The corn and chaff being placed in the hopper, pass through the aperture at the bottom into the shaking riddle, where it is at once acted upon by the wind from the fan, and the lighter chaff is blown off; the remainder passes through the riddles into the sieves below, where any other light material is again removed; as the grain comes forward towards the current the different sized grains, as well as the small seeds, find their way each into its proper place. There are a variety of differences in the details of these machines, but all agricultural machine-makers make very effective machines for cleaning the grain.

Messrs. Hornsby, of the Spittlegate Iron Works, Grantham, have paid great attention to this machine, and have received several prizes for their improved corn-dressing apparatus; the advantage consists in its being fitted with a spike roller, working through a grating, so arranged as to form a hopper; it is capable of separating the corn from the chaff in a rough pulsy state, as it comes from the thrashing-machine, without having been previously riddled, and is easily adjusted to suit corn either in rough chaff or any other state. It is also fitted with a double shaking-screen

at bottom, which more effectually cleans the corn from all kinds of small seeds than a fixed one can possibly do. For the second time over, the strap is removed, which puts the roller out of gear; and a board being placed in front of the gratings makes it an excellent machine for finishing the corn for market.

## HUMMELING-MACHINES.

These machines are for the purpose of removing the awns from the barley-corns; they are sometimes called barley-avelers or awners.

The most simple way in which this is done is to spread the barley out on the barn floor, about two inches thick, and with an instrument called a hand-hummeler (or barley chopper by labourers) chop the barley all over till the awns are cleared of the grain.

These hand-hummelers, though differently constructed, all act upon one principle, that of acting upon the barley with a series of blunt knives, or flat bars of iron, set edgeways in a frame of iron; they are sometimes made circular, at others square, and occasionally I have seen them made to revolve over the barley; when this is the case the blades are put between two circular plates of iron, and fitted with a handle, like a hand-roller; but all these hand-machines are exceedingly slow in their action, and ought only to be used on exceedingly small farms, or by cottagers. The machine-hummelers are much more effective, and not costly to purchase; they are made in a variety of ways, but all act on similar principles.

The largest description are formed of cylinders, about 6 feet long, of wire gauze; within this cylinder is an upright shaft, having (radiating from its centre) a series of blunt blades, about 2 inches in breadth; at the top of the cylinder is a hopper, through which the barley is admitted, and at the bottom is an aperture for its exit; the degree of

rubbing it sustains from the revolving blades depending on the size of the opening through which it is allowed to escape, and which is easily regulated, a very high velocity is given to the upright shaft and the blades, to ensure their efficient action.

Messrs. Ransomes manufacture a barley-hummeler of an efficient character. It consists of a perforated iron barrel, on a wood stand, with a revolving spindle, fitted with blunt knives, which revolve at a high velocity. There is a slide at the bottom of the hopper to regulate the feed into the barrel; beneath this is another slide to regulate the passage of the barley down the spout when finished. Care is requisite not to fill the barrel too full, as it increases the labour of turning, without any corresponding advantage. A rough sample of wheat is much improved by running it through this machine.

From eight to ten quarters of barley may be run through per hour by a man and a boy. Messrs. Garrett also manufacture an excellent machine with the cylinder inclined instead of horizontal, as in Messrs. Ransome's, or upright, as in the old machines; it effectually rubs off the awns from the barley, and screens away all loose rubbish from the corn, leaving the kernels clean and the sample brighter.

## THE SMUT-MACHINE.

This is a very useful machine, not costly, and consuming very little power; therefore one ought to be attached to all farmeries, where anything like a regular system of machines is erected. We all know how much the state of the sample of wheat, as regards cleanliness and soundness, affects the price it will fetch at market, and therefore how much it must be to the farmer's advantage always to send his corn, of whatever description, to market in the best possible condition.

The smut-machine is so called, because chiefly used by

millers for extracting the black specks, or powder, from wheat which has become smutted.

Smut in wheat is an exceedingly common disease of the plant; it shows itself by a black powder taking the place occupied by the farina in sound corn, within the husk; it attacks all sorts of corn, and presents a great diversity of appearance, and bears a number of popular names; it arises from two minute conimycetous fungi—the *uredo segetum*, and the *uredo fœtida*: sometimes it exists only in exceedingly small specks, and at another the whole of the shell of the grain is full of fine sooty powder.

It may easily be imagined, that wheat so affected, when ground, will be very inferior in appearance to sound wheat flour. The smut-machine is therefore employed to clear out from the wheat all the black matter that may be in it, which it does most effectively; and not only the actual smut is taken out, but all other dirt and foreign matter is removed, while the grain assumes a clean, bright, and polished appearance, which millers like, as they know it will make superior and brighter flour.

Fig. 28.

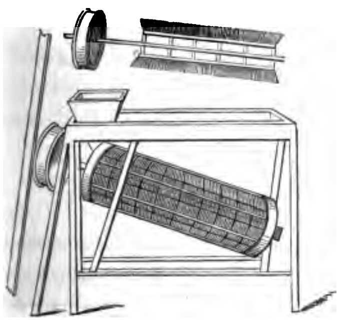


Fig. 28 represents the ordinary manner of constructing smut-machines. In a wooden case, enclosed on every side, is placed a cylinder of stout wire, and inclined downwards at a considerable angle; the cylinder is constructed in every respect similar to an ordinary dressing-machine; through the centre of the cylinder is a shaft, upon which is placed a series of arms, and lengthways of the cylinder; upon these, spars of wood, which carry strong brushes. The wheat is

admitted at the upper end, and in passing through the cylinder is forced against the wire grating, while the action of the brushes effectually forces the smut or dirt through the meshes of the wire, or any small seeds that may have escaped the winnowing-machine; the dirt remains in the box outside the cylinder, from whence it is occasionally removed; and the amount of filth that will be brushed out from the wheat after it has been made as fair a sample as possible by the fanners, will prove to any one the necessity of its always being used.

### SEED-SEPARATING MACHINE.

A variety of machines for effecting this object have been devised. An excellent one was invented by W. Robinson, of Belfast, and exhibited by Messrs. Deane, Dray, & Co., at the Smithfield Club Show last year. It consists of a long wire screen, set at an angle, and composed of a variety of different-sized wire gratings: to this screen a peculiar reciprocating and shaking motion was given by means of a crank placed at its lower end; it will clean and separate rye-grass, taking away the foil-grass, black seed, and all other small seeds, by only passing once through the machine, and likewise make a perfect sample of flax-seed and corn.

## CHAPTER IX.

### GRINDING-MILLS.

Some machines for bruising or grinding corn must have been used in the most remote times. The first doubtless was a kind of bowl, in which the wheat was pounded as with a pestle and mortar. It is a remarkable fact that the most ancient mills of which we have any account are nearly upon

the same principle as those in common use at this day, that is, composed of circular flat stones, the bottom one fixed, the upper one revolving upon it. At first these mills were made to hold in the lap, and work with one hand, and afterwards by levers, in the manner of a capstan. Nor was this the only form in which the mill-stones were made, for we have several actual specimens in existence of very ancient conical mills, which are the more interesting now as there are several conical mills lately introduced, and one of the most recent seems very likely to be generally introduced.

The construction of corn-mills for the manufacture of flour on a large scale cannot be considered, strictly speaking, as a portion of the regular business of the farmer, but as farms are increased in size, and a more regular system of machinery established in the steadings, and engines of larger power employed to drive it, there can be no doubt but that a properly constructed corn-mill, working two pairs of stones, will be constructed in every case; for although a number of ingenious mills have been invented, and are manufactured for the various purposes required by agriculturists, none of them can compete in efficiency with a pair of good burr-stones. It is true there is one great drawback in the use of stones, that is, the difficulty of dressing them; but in large farms employing a large quantity of machinery, one man will be required to devote himself entirely to the engine and machinery, superintending the driving it, and keeping it in order and repair: this man might soon acquire the necessary knowledge to dress the stones, as a part of his ordinary duties. I have no fear but that when a man of superior intelligence and character is required in the steading, and a little encouragement given in the shape of better wages, he will soon make his appearance. I have remarked that a knowledge of any new implement or machine is very quickly acquired by a smart agricultural labourer, and in a very short time he becomes

quite an authority about its characteristics, and the best time and manner of using it; he only requires to be properly instructed at starting, and practice will soon make him perfect. In all large steadings a pair of stones should be erected in a proper manner, that is pretty much the same as in small corn-mills, and attached should be a dressing and a smut-machine. A short description of these machines may be of value here, as this book is intended specially for persons in the colonies, who may not there have access to more elaborate treatises. As a foundation for the stones, and to carry the bearings of the machinery, it is usual to construct what is called the "mill-hurst." This is composed of iron columns and girders, if of iron, but as our object is to describe the simplest and cheapest, we will presume it to be made entirely of wood, and for two pairs of stones.

A solid foundation having been obtained, stout sills of oak are framed together, forming a parallelogram. Upright pieces are then placed at each angle, and lintels on the top, the whole mortised and tenoned together, forming a substantial frame, upon which the machinery is to be placed: across the top of the frame, in its shortest dimension, are placed deep pieces of timber as joists, called the stone-bearers; upon these are placed the lower stones, called the bed-stones; this is carefully laid, wedged perfectly true, and should be quite steady and firm in its seat.

Directly above the sill of the hurst in the centre, and crossing it, is introduced the driving-shaft, or as it is called by millers, the lay-shaft; one end of this runs in a plummer block securely placed on the sill of the hurst; the other usually passes through the wall of the mill, and is carried outside the drum which drives the mill, or if a water-wheel, it is the water-wheel shaft introduced into the mill as a lay-shaft at once. Upon this shaft, a short distance from the centre of the hurst, is placed vertically a large toothed wheel called the pit-wheel; the teeth are generally of wood

and work into a small horizontal iron toothed bevel wheel called the waller, placed upon the upright shaft; in the bottom of this upright shaft is an iron gudgeon which works in a solid brass bearing. As the centre of the upright is exactly over the horizontal centre of the lay-shaft, it is evident that some means must be adopted to carry it; the ordinary manner is to carry a bridge beam across the hurst lengthways; each end of the block is supported on a beam, which is tenoned into the uprights that form the hurst. The brass bearing on which the gudgeon of the shaft works is placed on an iron carriage fixed to the bridge beam, and is adjusted to a fixed centre by four screws on the carriage. Directly above the waller upon the upright shaft, is placed another wheel not bevelled, and much larger than the waller called the crown wheel. This wheel usually has wooden teeth, and these work into the teeth of the stone nut or pinion. Through the centre of the lower, or bed stone, is cut a circular hole, through which the spindle passes to carry and turn the upper stone, or, as it is called, the runner. The two stones are circular and of the same diameter, but the runner is usually much thicker than the bed-stone; these will be found described under the head of mill stones. The upper stone has a large hole cut through the centre and securely fixed; across the bottom of this is a strong iron bar or bearing iron; this is made square and bent downwards so as to form an arch. It is necessary in the process of grinding, that the upper stone should revolve with great velocity above the lower, not touching, but the distance adjusted with great nicety, as much depends upon it as to the sample of the flour when ground. We have before said, that through the centre of the bed-stone, there is placed the spindle, which is a stout bar of iron, the bottom resting upon a brass bearing, to which we shall presently allude, and on the top is a large boss of iron having a slot cut through large enough to admit of the bearing

iron before alluded to, dropping into it; on the top of the bed-stone, over the hole through which the spindle passes, is placed an iron plate, the upper surface of which is level with the top of the bed-stone; the lower surface of the boss on the spindle works down upon this and prevents the flour working through.

We have before remarked, that the space between the stones requires to be adjusted with great nicety; some arrangement must therefore be made to raise and lower the bottom of the spindle which supports the upper stone or runner.

In very old mills this is effected in a very simple manner; between the two upright posts that form the hurst is placed a beam, one end being formed into a large tenon and let into a mortise in the post. Through the post and the tenon is passed a pin, upon which the beam is supported and allowed to move; the other end of the beam is worked upwards and downwards on a slot, by a capstan-headed screw; on the centre of the beam is placed the brass bearing to receive the arbor of the spindle. This beam and the runner above are often regulated by a governor, which will be found described in the chapter on the steam-engine.

Upon the spindle is placed a small cog-wheel called the stone pinion or stone nut; the cogs or teeth of this wheel are placed exactly opposite the cogs of the large horizontal wheel called the crown-wheel, and from that it receives its motion.

We have now arranged the means of driving the stone pinion and the runner, and provided the means for regulating the action of the stones; but there is another provision to be made, that is, the means of disengaging the stone pinion from the crown wheel, so that one pair of stones may be run alone, or, if necessary, both pans disengaged and the upright shaft driven by itself for the purpose of working the machinery attached to it, and placed in the upper floors of

the mill. This is effected in the most primitive forms of mills by removing one of the wooden teeth from the pinion, the teeth of the crown wheel then passing by without touching; this is an exceedingly rude method of working, as the moveable teeth will soon become loose. A better plan is to have the pinion set on a square on the spindle, and by means of levers it rises up clear of the crown wheel, and remains so until required to be used. The description of mill we are describing is of the simplest form, which I think is therefore more likely to be understood by non-professional readers; but both for the purpose of lifting the runner and ungearing the pinion, beautiful mechanical contrivances are adopted by millwrights, which work with the greatest accuracy and facility, and I regret not having space to describe them in detail.

We must now proceed to the upper stage of the mill for the purpose of tracing the course of the wheat through the mill, until it leaves it in the shape of meal.

The wheat is placed in hoppers, which are conical-shaped boxes, having an aperture at the lowest point through which the wheat passes into shoots or spouts to smaller hoppers placed over the mill stone; at the lowest point of these hoppers is an aperture through which the wheat passes into a small spout open at the top and placed nearly horizontally; the lower hopper is placed on a framework which stands upon the wooden cover of the stone called the hoop. Nearly at the end of the small shoot is a hole through which the wheat passes into the large aperture in the centre of the runner; a jerking motion is given to the shoe by a peculiar shaped spindle, worked from the stone below. The wheat having now arrived at the grinding stones, some description of them is necessary before proceeding farther.

*Mill Stones.*—These stones are made of a variety of materials, of a stone brought down the Rhine and called peak stones, sometimes sienite or granite; but the

material that of all others is preferred is called burr stone: this is found in the mineral basin of Paris, and although an immense quantity of it is quarried, inasmuch as the revetment walls of the fortifications of Paris are made with it, yet it is only small selected pieces that will be found fit for mill-stones.

The burr stone is geologically the uppermost stratum of the solid crust of the earth, there being nothing about it but diluvial gravel, sand, and loam. The stones are quarried in the open air and sent to this country in pieces, where they are sold at so much per pound, the ordinary selling price being for good sorts, about *5d.* per pound. The mill-stone makers, in constructing the stones, which are often of large diameter, have to face a number of pieces, and assort them with great care; they are then cemented together with plaster and secured with iron hoops or bonds. Good burr, or, as they are often called, French stones, should exhibit a positively cellular texture, the cells being irregular in size and shape, and often cut transversely by thin plates of silex; it should be exceedingly hard without being brittle; the best stones are of a warm white or yellowish grey, and sometimes a tint approaching to blue.

The facing these stones is an important matter; they are first worked down to an uniform level, and narrow shallow chases are cut, radiating, though not directly from the centre; various arrangements of these channels (which are called furs) are made by different makers, but there is a fixed angle at which they are generally set out: they must on no account allow the centrifugal force to shoot the wheat through them to the outside, which I have known some arrangements of the burrs do; for if this is the case the wheat cannot be evenly ground. The surface of the stones between the furs will of course in the process of grinding wear smooth and assume a polish; as soon as this is apparent the face has to be chipped, or as it is called, sharpened or

pricked. This is done with a tool called a mill-bill, which is a double steel wedged chisel, ground sharp on a flat stone; this is placed in a handle, and the miller resting on the stone and supporting his hand on a cushion, keeps up a succession of sharp blows with the bill, making a small indented line or cut on the stone; these pricks or marks being close together and all over the surface of the stone, produce a texture or tooth which is the grinding power. The quantity of meal a given pair of stones will grind, as well as the quality of the meal, will depend a good deal upon the state of dress or surface the stones may happen to be in while employed.

To return to the operation of the grinding the wheat: after it is shaken from the spout it descends upon the centre of the lower stone, and passing outwards by the centrifugal force imparted to it by the rapid revolutions of the upper stone, it is ground between the two rubbing surfaces; the same force drives it, when ground, to the outside of the stone. Both stones are covered with a wooden circular framing called the hoop, the sides of this keep the meal from rushing outwards; between this hoop and the bed-stone is an aperture in the floor through which the meal passes by a shoot to the meal-bins below.

Wheat that has simply passed through the stones is in that state called meal, and not flour, till it has been dressed; for in the state of meal it of course contains the husks of the grains of wheat broken and bruised, but still mixed up with the flour. It is necessary, therefore, that the meal should undergo some other process by which the husks will be extracted. This is done by machines called

*Dressing or Bolting Machines.*—Bolting is the operation of separating by sifting the finer particles of the meal from the coarser. The machine consists of a cylinder formed of wood ribs; upon these are strained a cloth as fine as wire gauze, and of different degrees of fineness; within the cylinder, passing

through the centre, is a shaft, and upon this, at intervals, are placed radiating arms; extending the length of the machine upon these arms are spars of wood to which brushes are fixed the whole of their length; the cylinder is not set level, but at a certain inclination. The meal being admitted at the upper end of the cylinder, and a high degree of velocity being given to the brushes which revolve upon the horizontal shaft, the finer particles of the meal are forced through the finest gauze, and as it descends the sections of the cylinder, being covered with different cloths of different degrees of fineness, the particles of the meal are forced through the different sized meshes of the screen according to their sizes; the bran or husks, being carried right through the cylinder, and descend through an aperture at its lower end to a receptacle placed for them.

This ingenious machine was invented and patented by John Milne, A.D. 1675, and is thus described:—"A machine for dressing flour of wheat or barley, which will make a more lively and better flour than bolting-cloths (which is the common method now used), from the same corn. It will dress all sorts of flour, and divide the sharps from the bran at one operation, and the person that attends it may easily make two sorts, or only one, by moving the partitions that divide the flour, which must be within the box or case in which the machine works; and as flour is an article that loses every time it is stirred, it evidently appears that it dresses with less loss, because it does that business at one operation which, to be done with cloths in the common method now used, requires several operations and several different cloths, and the trouble of changing them, they being obliged to change their cloths for different sorts."

The patent was for brushes, either lying parallel to the axes of the cylinder, or formed like a screw or worm; either the brushes to revolve in the cylinder, or the cylinder to revolve also.

Very little alteration has taken place in the construction of dressing-machines since this patent; but a number of different plans are put forward by makers of corn-dressing machinery.

A variety of patents have been obtained by various persons, at different times, for improvements in the construction of corn-mills, but scarcely any have come into use. We will notice such as have been at all successful, and must pass over the infinite variety that have not.

Grinding with metal plates has been tried, and with some amount of success, by various persons, and Mr. Croskill's present eccentric mill seems likely to come into general use. The first of these mills worth notice is generally known as the French Military Mill, and was the invention of Francis Devreux, to whom a patent was granted for it in 1824. The principle is that of metallic groove plates turning on a vertical plane; the grooves cut radiating from the centre of the plate. One of the plates is fixed to the end of the frame of the mill; the other revolves upon an axis fixed in the centre of the fixed plate at one end, and in the side of the frame in the other.

The grain is fed through an aperture in the fixed plate, and having been subjected to the action of grinding between the two plates, passes through an opening at the bottom into a hopper, and thence to a bin. The manner in which the grinding plate was regulated in this mill was exceedingly well contrived, and was, in fact, the novelty, for vertical mills had been used before.

*Sharp & Roberts's Mill.* — Messrs. Sharp & Roberts received a patent for this mill, 1st Jan. 1834; it was the invention of a foreigner, and is novel and ingenious.

The object sought to be obtained in this invention was to increase the triturating effect of ordinary grinders, by placing the lower stone, which in this case is the runner, eccentric with the bed-stone, which is here uppermost.

The corn descended by a funnel through the centre of the upper stone or grinder (for the patent was for metal or stone grinders) into the lower, as in the ordinary mills, except that in the former case the pressure is upwards, while in the latter it is downwards. The lower stone or runner was supported on a vertical shaft driven in the ordinary manner, and the space between the upper and lower stone was regulated by a wheel and screw which lifted or depressed the cup in which the vertical shaft is placed. We shall have occasion hereafter to allude to this mill.

In 1835 Mr. Herbert took out a patent for an exceedingly simple mill for grinding and dressing flour. The corn is placed in a hopper, through the centre of which is a vertical shaft; on the top of this is placed, horizontally, a mitre wheel; across the centre of this is placed a horizontal shaft, having a fly-wheel at one end, and at the other the wind with which the motion is imparted to the machine. The mitre-wheel on the vertical shaft gears with a corresponding one on the horizontal shaft, and this motion is given to the grinder below, and some brushes contained in a circular box, the bottom of which is covered with moveable wire gauze. The flour as it descends from the stones falls upon the gauze and passes through to its receptacle beneath, while the bran is driven outwards by the action of the brushes, falling into a screen of coarse wire, where the bran is separated from the pollard.

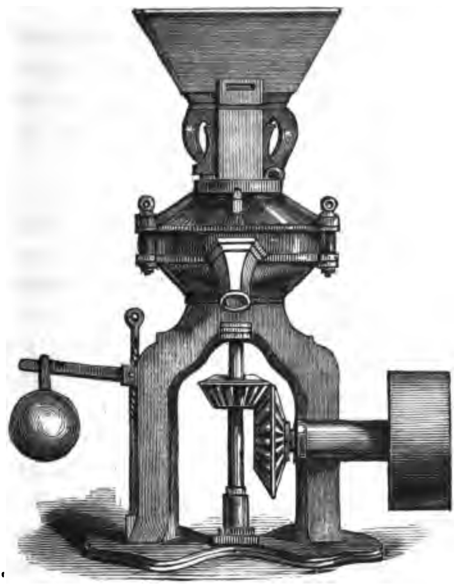
Another mill invented by Mr. Herbert, consisted of vertical grinding plates placed at one end of a dressing machine, the grinding apparatus being much the same as Devreux's mill, the vertical grinder running upon the shaft of the dressing machine. This is an exceedingly compact and effective machine, the various qualities of the flour and offal being deposited in their respective compartments, under the machine.

*Croskill's Universal Mill.*—This machine has lately been

introduced by Mr. Croskill, of Beverley, Yorkshire, and bids fair to become one of the most extensively used and useful machines that the farmer can have upon his premises.

The term "Universal Mill" is justly applied to this mill, for its grinding powers are almost unlimited; it is said to grind equally well ever so fine or ever so coarse. I have seen it employed in grinding raw flints, coprolites, quartz, bones, charcoal, paint, all kinds of grain, merely bruising, or making good meal. I think this machine quite capable of effecting all the different operations; grinding, crushing, bruising, or splitting, that may be required in the homestead;

Fig. 29.



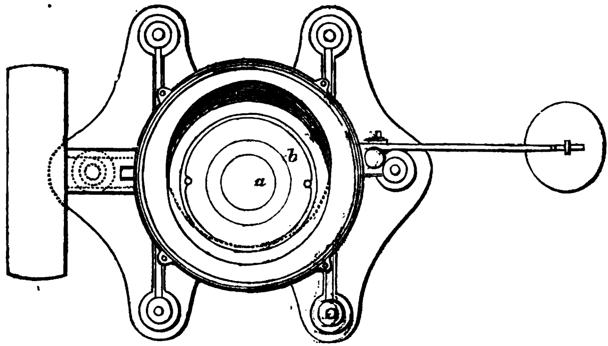
CROSKILL'S UNIVERSAL MILL.

the grinding-plates being varied according to the change of work.

Figs. 29, 30, and 31, represent an elevation and section

of the mill, the principle of which consists in *an upper and lower grinding-plate running in the same direction, and at nearly equal velocities, but not on the same centre;* hence it is sometimes called the eccentric mill. Grooves are cut in the surface of the plate in circles radiating from the same centre; these circular edges act like revolving shears,

Fig. 30.—Plan.



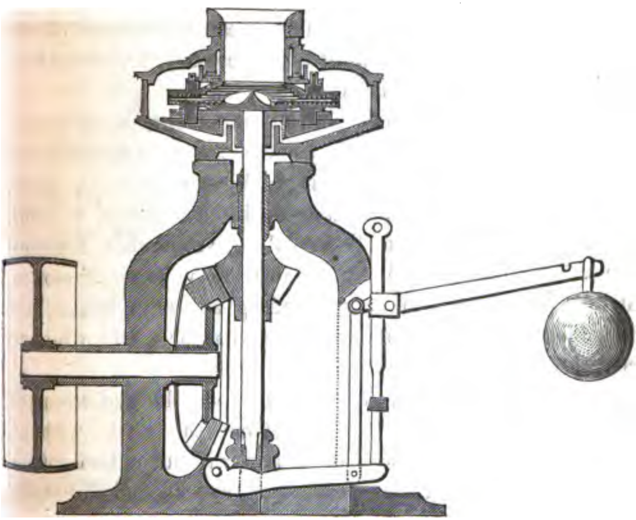

cutting every way, and producing a most perfect grinding or cutting action.

There is considerable similarity between this mill and the one patented by Sharp & Roberts in 1834: both are eccentric, but in Mr. Croskill's the action is much more perfect. This mill is exceedingly portable, and occupies very little space. In working, it should run to the right, and at a speed of not less than 300 revolutions per minute; and it may, if necessary, be run up 800. An arrangement is made to prevent accidents, by a guard lever which relieves the mill of any obstruction requiring greater power than crushing the material the mill is grinding. The weight is so arranged as to keep the plates up while grinding.

The distance between the plates is regulated by an adjusting screw, and the mill will thus grind coarser or finer, as may be required.

In removing the upper plate from the mill a lever is

Fig. 31.—Section.



placed in the hole in the ring which is on the top of the mill; this screws the ring off, and separates the plates: being a back-handed screw, for the purpose of keeping the ring on the tube while the mill is running. The following directions are given as to oiling the mill:—There are three principal places to be well supplied with oil. The first is the step in which the lower end of the shaft revolves; the second is the box which holds the shaft in its upright position: this is done by pouring oil through a tube which leads to the box; the third place is the upper bearing of the mill. In this is a large reservoir for holding oil; it is poured in through a tube just over the bearing of the mill. After it

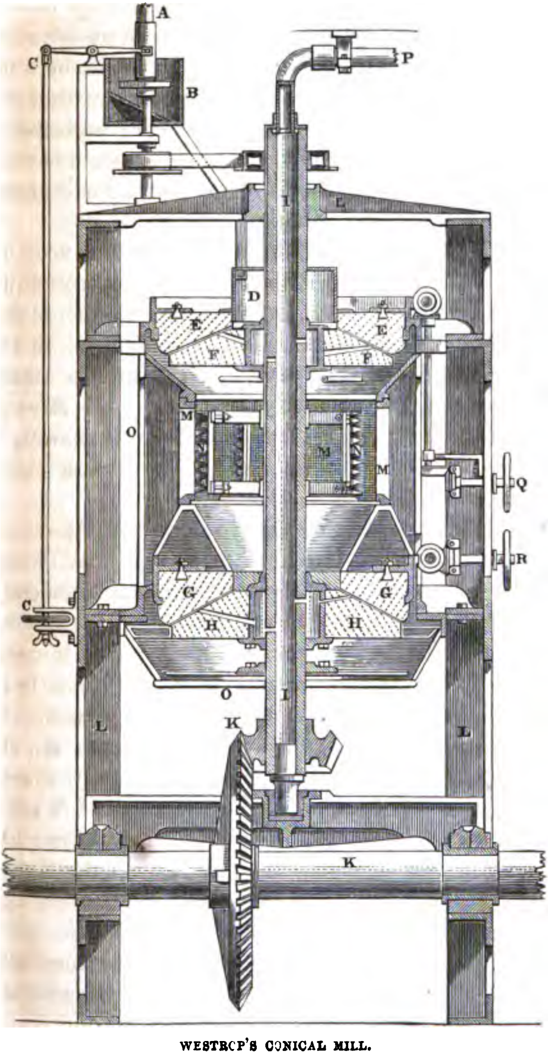
is supplied with oil, a stopper should be put in the opening to the tube to prevent the dust from getting in. The adjusting screw is held firmly in any position by a small screw against its side. The feeding is regulated by a shoe, acting against the tube of the upper plate, which causes the shoe to vibrate; this with the side of hopper regulates the quantity put into the mill. The mill can be taken to pieces, cleaned, and the plates changed, if necessary, for coarser or finer grinding, in a few minutes.

*Westrop's Conical Mill*, fig. 32, represents a section of this mill. As Croskill's is, in some measure, a modification of Sharp & Roberts's mill, so is Westrop's in a slight degree similar to one patented by Luke Herbert, in 1833, for both Herbert's and Westrop's have double arrangements for grinding, with upper and lower pairs of stones. Mr. Herbert's remarks upon grinding are so judicious, and his object so fully explained, that it may be worth while to give them in his own words:—

"In grinding wheat it has ever been the endeavour of millers to separate all the flour from the husk, without pressing it so hard as to 'kill it,' and without deteriorating its colour by making many minute 'greys.' This they have not been able to effect in a convenient or profitable manner with the mills constructed on the usual plan, nor by any form of construction that has hitherto appeared. The reason is obvious: if the stones be brought so close together as is necessary to remove the firmly adhering portions of the flour from the husk, the whole of it will be, in a great measure, 'killed' and discoloured by the violent rubbing necessary to clean the bran; on the other hand, if the stones are kept further apart, so as to 'grind high,' much of the flour will be left in the offals and bran.

"These disadvantages, which are inseparable from the old system, are completely obviated by the 'Patent Portable Progressive Corn Mill,' from the following causes: 'Instead

Fig. 32.—Section




WESTROP'S CONICAL MILL.

of employing only a single pair of stones of great weight and diameter, a progressive mill consists of *two pairs of stones of smaller diameter, with a flour-dresser between them*, into which the meal from the top pair of stones freely descends; two-thirds or three-fourths of very superior strong flour is thus at once produced, while *the unfinished portion falls into the eye of the second pair of stones* underneath. This second pair of stones are set closer together than the first, to complete the softening of the remainder of the meal, which, in consequence of the bulk of the flour being separated from it, is much more easily operated upon. Underneath this pair of stones is placed a common dressing machine, into which the meal falls as it is ground, where the remaining flour, as well as the different qualities of offal, are separated in the usual way." In Mr. Allen Ransome's "Implements of Agriculture" will be found a drawing and description of this mill, as well as many others equally interesting.

The principal difference between Westrop's mill and Herbert's lies in the shape of the stones. In Herbert's they were flat surfaces, in Westrop's they are conical, and not much different in principle from the ancient mill called the Pompeian mill, which ground by two conical stones, the lower fixed and the upper revolving upon it. It is 1700 years since the city was burned by the ashes from Vesuvius, during a terrible eruption, but there is a conical mill perfect, (truly the ancients left us nothing to do in the way of mills). We extract the following description of Westrop's mill from the "Illustrated London News" (supplement):—

"In presenting our readers with the subjoined plan of Westrop's Conical Flour Mill, we think it necessary to remark, that for the last three centuries our best mechanical millwrights and engineers have been seeking some better method of grinding wheat than by the use of the antiquated horizontal mill stones. These stones are most of them from

four to five feet diameter: and wheat passing between them in the operation of being ground into meal, is subject to such an amount of heat by pressure and friction, as to extract from it, by evaporation, a very considerable portion of its nutritious qualities: the stones being horizontal, the delivery of the meal after grinding can only be effected by the extreme velocity with which the upper stone revolves. Under the disadvantageous circumstances in which our older millers have worked for so many years, we cannot but hail an invention, as effective as it is simple, which completely provides against the evils which the old system is subject to. The improvement we refer to is the adoption of conical stones in lieu of horizontal ones, with a working surface of only 8 inches instead of 2 feet. By the first pair of stones the wheat is broken and delivered in a state of half-ground meal, unheated, and by the natural laws of gravity the flour is instantly passed through a wire cylinder fixed beneath, by the aid of brushes fixed upon the same shaft as the stones. The flour being thus instantly separated from the unground meal, the latter passes down to the second pair of stones, also fixed upon the same shaft, and the grinding is then completed. Moreover, we cannot refrain from expressing our admiration of the concise and beautiful adjustment of the stones, as being on a good sound principle. The lower, or running stones are keyed upon the shaft, whilst the upper or stationary stones drop into a turned ring, and necessarily rise and fall upon four inclined planes, and are capable of regulation to the utmost nicety, thereby wholly relieving the wheat from any undue pressure during the operation of grinding, whilst the weight upon the old system was equal to three quarters of a ton. Another feature of paramount importance is, that the conical mill can be driven by less power than is required to drive the horizontal ones, the former producing double the quantity of work in the same period of time. We have

perused certificates from several respectable bakers who have used the flour produced by this method, which state that a sack of flour manufactured by the conical mill will produce from two to three 4lb. loaves more than that which is made by any other mode of manufacture; and they attribute this increase to the greater quantity of gluten and nutritious qualities retained in the flour, from its being so much less heated, the wheat passing over such a small surface of stone.

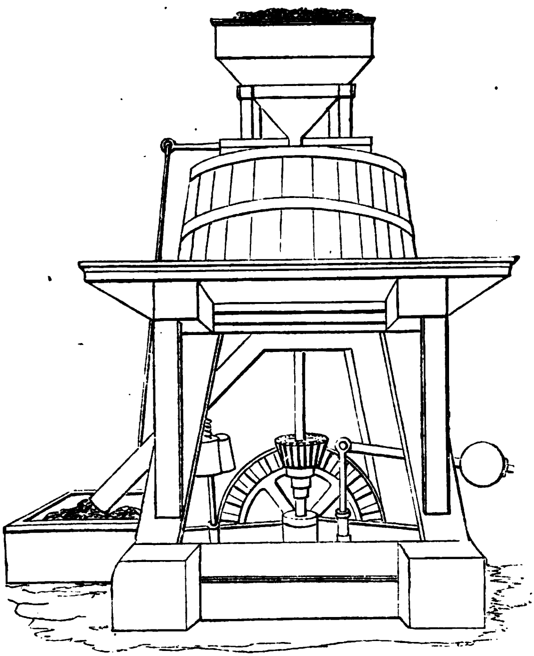
*Reference to Plate.*

A, Feed pipe.
B, Chamber containing the feed regulator.
C, Feed regulator.
D, Chamber over the eye of the stones which receives the wheat from the regulator.
E, Upper top mill stone (stationary).
F, Upper runner.
G, Lower top stone (stationary).
H, Lower runner.
I, Hollow spindle upon which the runners are hung.
K, Bevil wheels and driving shaft.
L, Iron frame sustaining the whole machine.
M, Upright wire cylinder acting as a partial dressing machine.
N, Brushes acting upon the wire cylinder M.
O, Wooden case enclosing stones and cylinder, to the bottom of which the spout is fixed.
P, Pipe to convey cold air into the face of the stones, the inside of the hollow spindle I conducting the air to the stones.
Q, Regulator for adjusting the upper pair of stones.
R, Regulator for adjusting the lower pair of stones.

*Garrett's Stone Mill.*—This is a most excellent mill for agricultural purposes, where a large quantity of work is required to be done in grinding wheat and other farm produce. The stones are 32 inches in diameter, and enclosed in a metal and wood framing. The top stone is hung on an upright shaft, and worked by a pair of bevil wheels, from

which the attachment may be made to either steam, water, or horse-power. Its construction admits of the stones being readily adjusted for grinding wheat, barley, beans,

Fig. 33.



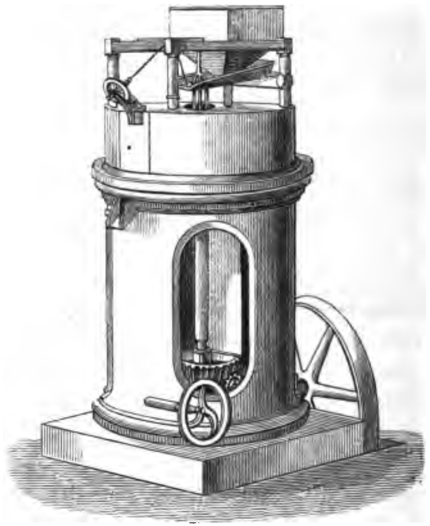
GARRETT'S STONE MILL.

or peas. The framework of the mill is most excellently constructed of timber of large scantling, and perfectly secured by iron bolts. It is in every respect a first-rate mill, and one that we specially recommend for farms of any magnitude.

Messrs. Clayton Shuttleworth's mill is similar to Messrs. Garrett's, only the frame is made of iron instead of wood;

the stones being supported on a handsome iron cylinder of good design, and inside which the driving gear is placed.

Fig. 34.



CLAYTON SHUTTLEWORTH'S STONE MILL.

It is in every respect a first-rate mill, and, as a piece of workmanship, does infinite credit to the firm that has produced it. They received a prize from the Royal Agricultural Society, at Exeter, 1850. At the Norwich meeting, 1849, the judges, after it had competed with thirty-two other mills, made the following report:—

"The portable mills, for grinding fine meal, did not possess much merit, with the exception of Messrs. Clayton Shuttleworth's, to which we awarded the prize. It both kibbled and ground in a superior style to any of the others, grinding barley perfectly well at the rate of six bushels per hour, without much heating the meal. It was upon the

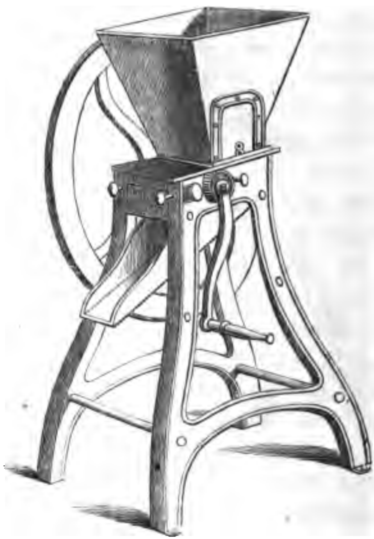
same principle as fixed mill-stones usually are, and well got up in point of workmanship, and took little room, so that we consider it a vàluable implement. The stones are 2 feet 8 inches diameter, fixed in a metal cylindrical frame, 3 feet 6 inches diameter, and 4 feet 7 inches high from the floor to the top of the bed stone. The runner is driven by the upright spindle, which is driven by a pair of bevil wheels at the foot, one geared with wood. The pulley shown on the outside is for running the strap which may be taken direct from the engine driving wheel; the small hand wheel in front is for adjusting the stones to their faces, at such distances as they may grind the finest flour, or only kibble beans, peas, or oats. Six bushels of barley per hour may be ground to fine meal by this mill."

The mills we have hitherto described are all of much too large and expensive a character to be used on small farms, and yet small farms require exactly the same operation to be performed as the large ones. Small farms are at a great disadvantage in this respect, as they cannot get the work done so cheaply as their more fortunate brethren, yet have to meet on equal terms in market; they are, therefore, obliged to buy several small mills to effect the different objects. These are of immense variety, and made of iron, and at a very cheap rate, and sold by all agricultural machine makers.

It is a most desirable thing to have a low priced mill that shall, by an alteration of grinding parts, perform the different operations of grinding meal for feeding stock (flour is better not attempted), and crushing, kibbling, splitting, or bruising, as may be required. Several attempts have been made, and, in some cases, with considerable success; and, in one I have remarked, it has answered capitally. It is manufactured by Barrett, Exall, and Andrewes, of Reading, and the difficulty we have noticed is overcome by having a double feed of exceedingly simple contrivance.

Fig. 35 represents the mill, which consists of three rollers parallel to each other, the two front ones slightly grooved; these are for crushing malt, oats, barley, and linseed, and are adjusted by two hand-screws. The back roller is cut

Fig. 35



BARRETT, EXALL, AND ANDREWES' PARAGON MILL.

for beans, and works against a plate as in the post mill; thus there are two separate mills in one, each fitted for its particular kind of work, and independent of each other.

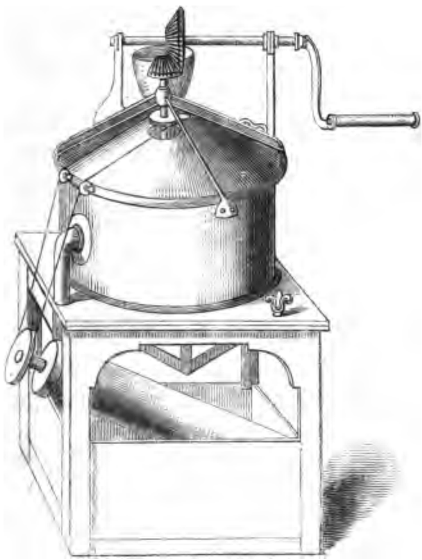
An iron shifting-plate regulates the feed to each opening as it is required.

This mill will crush about four bushels of barley or oats per hour, or about one of linseed and six of beans.

*Wood's Crushing Mill.* — In this case the crushing is

performed by means of a large wheel four or five feet in diameter, acting against one of as many inches. It is adapted for a variety of work. As it is rather a favourite mill several varieties are manufactured by different houses, but all using the large wheel against the small one.

Fig. 36.



DEANE, DRAY, AND DEANE'S DOMESTIC FLOUR-MILL.

Fig. 36 represents a small hand-machine called the domestic flour-mill, well adapted for emigrants and cottagers. A small, convenient, and cheap flour-mill, has long been a desideratum. Messrs. Dean seem to have supplied it; for this little mill does its work in a very superior manner, the meal being perfectly soft and fine as from a large mill; it also dresses and separates the flour, seconds, and bran, at the same time, and in a manner we should not

have expected in so small a machine. It is constructed in an exceedingly compact form and is very portable.

*Crushing-mills.*—A variety of machines are constructed for crushing linseed and other grain, as well as for breaking the cake, either as food for stock or as manure.

Messrs. Garrett have produced a powerful machine for the purpose of breaking cakes of any size or thickness: it is fitted with two sets of barrels, which may be adjusted as required, to break cake into different sized pieces for bullocks or sheep, or powder for manure.

A screen is fixed between the barrels, through which as much of the cake as is sufficiently broken in passing through the first is sifted, to ensure uniformity of size, and avoid the unnecessary labour occasioned by that which is sufficiently broken passing through the bottom rollers with that which is not.

Cake-breakers are made in a simple and cheap manner by nearly all implement-makers, and the action is in nearly all cases effected by two grooved or notched rollers.

*Bone-mills.*—The steading which has a properly fixed steam-engine, has a great advantage over those which have not, as there are a number of operations that can be laid on the engine that could not well be effected by horse-power. Among these, the grinding of bones for manure is an important one, bone-dust having become one of the favourite and most generally used artificial manures, and should be purchased by the agriculturist in a state that he can himself judge of the quality of the article he is purchasing. If he buys bone ready ground he will have great difficulty in doing this. It is, therefore, necessary that he should buy them unbroken and grind them himself. Experiment, it is said, proves that bones that have been boiled are just as good for the land as bones upon which the fatty, fleshy, and fibrous matter remains. This I do not believe, if the result be taken at the end of several croppings;

but I do believe that the boiled bones are taken up as food by the plants much quicker than the others; and, as a quick return is most wanted by the farmer, there is no doubt that boiled bones ground into powder, and drilled in with the seed, is the best possible method of using this valuable and highly fertilising manure. I have alluded to the using green or boiled bones because (admitting the necessity of the steading being provided with a bone-mill) a very much simpler form of mill will do for the dry bones than would be required for the green.

Bone-crushing is at present done quite as a separate business, and the mills are large and expensive; but I see no reason why a small bone-mill should not be constructed adapted to large steadings. At present I do not remember to have seen such an one, but possibly they may be to be had.

Bone-grinding is effected by passing the bones through a series of toothed rollers arranged in pairs, the rollers being toothed or serrated in different degrees of fineness, and riddles are provided for sifting the bones into sizes, and they are then sold as inch, three-quarters, half-inch, and dust.

It is in the latter state that the farmer is most open to be cheated by dishonest dealers; and, therefore, half-inch bones are often preferred, not because they are so economical or so immediate in their action as drilled bone-dust, but because the buyer can better tell the quality of the article. A variety of different materials are employed to adulterate bone-dust: such as the refuse lime of tan-works, after it has been employed in removing wool and hair from the skins. This is passed through the rollers along with the bones, and as it has a strong pungent smell it is easily mistaken. Doubtless this material is a fertiliser, but if it is it can only be in a small degree, and is certainly a robbery on the purchaser of bone-dust. Old mortar, soap-boilers' waste, saw-dust, slaked lime, rotten wood, and a variety of other

materials are used to deceive and rob the farmer: hence I conceive a small cheap bone-mill to be a necessary machine to farms of any magnitude.

*Cyder-mills.*—The manufacture of cyder, in the apple-growing countries, as Herefordshire, Devonshire, &c., is an operation of great importance, and conducted with all the care and attention that is bestowed upon any other process for converting the produce of the land into a marketable commodity. Cyder is made from the juice of fruit expressed by the action of a powerful mill.

Cyder-mills are often constructed by setting up a single or double edge runner on either side of an upright shaft, which is turned by a horse working in a track; but several cyder-mills have been constructed on the principle of screw-presses. A silver medal was awarded to Mr. Alexander Dean, of Birmingham, for a new cyder-mill at the Royal Agricultural Society's Meeting at Derby. It was the invention of Mr. Ashwood, of Bretforton, Worcestershire, and is thus described in the Journal:—"This implement is, in fact, a crusher or squeezer, being furnished with a piston worked horizontally in a substantial wooden box, from which the apples are discharged in a state of pulp. Mr. Ashwood describes its mode of use thus: 'I drive it by a one or two-horse-power used for chaff-cutting, &c., and place it as near the cellar as convenient. It requires two women—one to carry the fruit from the heap and throw it into the hopper, the other to regulate the feeding with her hands; two men to remove the pulp and press it through hair cloths, the same as with the old mills, and one to carry and tun the cyder. The quantity of fruit it is capable of reducing varies according to its ripeness, from 300 to 400 bushels per day, and produces from 800 to 1000 gallons of juice. Several of my neighbours have already bespoken the use of my mill for the present year, who have seen the efficiency of its work, and the peculiar way in which the cyder keeps from

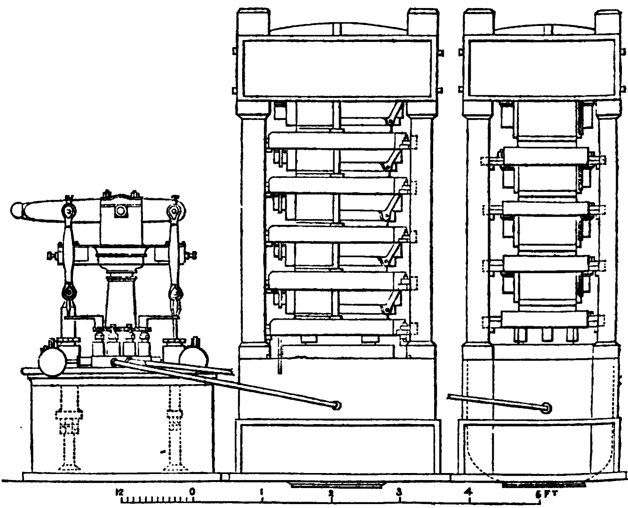
it. I also tried it last winter for pulping turnips and potatoes, for pig-feeding, and found it most economical. The juice is not squeezed out by it, but the pulp is beaten up to about the consistence of paste, which I mix with barley or bean meal, and find the pigs feed much faster than when mixed with water.' This new machine was very well got up by Mr. Dean, and accommodated to manual as well as animal or steam-power. It has been represented to the judges that the grating of apples is much preferred in America for cyder-making to the old rolling-mill; the saccharine matter being much better evolved by grating, and the pips in a great measure reduced."

In Fullerton's Agricultural Encyclopædia, I find the following description of one of these grating cyder-mills exhibited at the Massachusetts Agricultural Society; it is thus described: "It has a wooden cylinder, upon the surface of which nails are fixed; the heads are sharp upon the edges and project above the cylinder about one-eighth of an inch. The apples are filled into a hopper placed over the cylinder, and led into a narrow cavity at the upper side of it. The cylinder is mounted on a high frame, its axes being placed in composition boxes. A rapid revolution is produced by connecting it with a horse-mill by belts or bands. The apples are reduced to a fine pomace, grated, not pressed. It performed well in the presence of the committee, and grated a barrel of russet apples in 1 minute 34 seconds."

## OIL-CAKE PRESS.

This, like the bone-mill, is a most important machine; for the cattle-feeder is cheated more in this article than any other. The common oil-cake sold for feeding stock is often adulterated with all sorts of rubbish. It ought to consist entirely of oil seeds, freed from a large proportion of their oil. When farmers have erected oil-expressing machinery, and made their own cake, an immense advantage has always

Fig. 37.




BLUNDELL'S HYDRAULIC CAKE AND OIL PRESSES.

been gained. And now that the culture of flax is likely to become general, the use of cake will also be more common, and the manufacture of it on their own premises be the common practice, as they will be enabled to get a much

richer cake for the same money. At present, the cake-presser's whole object is to extract as much oil as possible from the seed, for he gets just the same price from the farmer whether he extracts little or much; and certainly much of the cake imported into this country is so squeezed that little is left for the stock: and, not content with extracting every particle of oil, they recommence with downright adulteration, making the cakes up again for market.

Oil-cake presses are manufactured by Croskill, and most large concerns. Fig. 37 represents the patent hydraulic presses of Martin Samuelson & Co., of Hull. One press holds ten cakes of 3lb. each, and the other four cakes of 8lb. each.

The presses are easily fixed, and the wear and tear is trifling, being confined chiefly to the leathers of the pumps and the cylinder rams.

The pumps are made of gun metal, and, as well as the presses, are of first-rate workmanship. The great advantage of these presses over the ordinary stampers is in the increased quantity of oil extracted, and the extra amount of work that can be done.

## SACK-HOISTING MACHINERY.

Presuming farmeries to be constructed in their arrangements something more nearly to mills and manufactories, there will be required an easy method of hoisting sacks and other weights from the lower to the upper floors, or granaries. A common crane and windlass is often used, but this is an exceedingly slow process, and not always convenient.

In flour-mills it is necessary to have the means of hoisting with rapidity and ease the sacks of corn from the lower floors to the higher, for the purpose of emptying it into the hoppers for supplying the stones; or to raise the meal from the bins on the lower floors to the upper, to be passed through the dressing-machine; and for this purpose a machine, called a

sack-tackle, or hoist, is used. It is exceedingly simple, and answers the purpose admirably.

Sack-tackles are constructed in several different ways, but the one most in use is as follows:—

In the roof of the mill (though it might be in any other convenient place) is placed a wooden framework, moving with hinges at one end; across this frame is placed a shaft, or spindle, having upon it a wheel, or pulley, and a barrel to carry the chain or rope; in a line with the pulley, in some direction, and upon a shaft always kept running, is placed another pulley; over these two pass a strap, made so loose that the pulley in motion does not give motion to the other. At one end of the sack-tackle frame is a piece of iron, set up with a strong spring to press it forward, and having a projecting notch or ledge on the face of it. We have before observed that one end of the frame was moveable; when a sack is required to be hoisted, one end of the wooden frame and with it the shaft carrying the pulley and chain-barrel is lifted; the strap then works tight on both the running and the other pulley, and the chain or rope works round the barrel. The frame is lifted by a cord running through a small pulley above, and passing through a hole in each floor beside the sack-traps, through which the sacks are hoisted; when the frame is lifted by this cord, it passes up the face of the iron spring till it arrives at the notch, upon which it rests. The cord by which the frame is lifted is called the striking-in line. As long as the frame remains on the notch, the barrel continues to revolve and wind up the chain. There of course requires another arrangement to again slack the strap and stay the action of the winding barrel; this is effected by simply having a line to draw back the spring, upon which the frame descends to its former position. This line is carried down through the floors beside the other, and is called the "striking-out line." At the lower end of the chain is a ring large enough to admit of the slack being passed through

double; a loop is thus formed which takes hold of the neck or tie of the sack; the striking-in line is pulled with a jerk, and the sack ascends to the required height; the striking-out line is then pulled, and the sack drops on to the floor above the traps.

In some sack-hoists the strap is tightened by a lever pressing against it; the frame and barrel then being stationary, nothing taking place but the tightening of the strap by the lever. In others, a hollow cone is used, working on to a solid one, which is always moving; but the ordinary one we have attempted to describe.

## CHAPTER X.

### MACHINES USED IN PREPARING FOOD FOR STOCK.

*The Chaff-cutter.*—This machine has only been introduced of late years in an effective state, although the cutting of plants and leaves as food for stock is spoken of by the earliest writers. The chaff-cutter first used in this country, and only introduced so lately as the close of the last century, consists of a plain box or trough, placed on four legs, and fitted with a large knife or blade, one end of which was secured to the end of a lever, and the other had attached to it a handle. The material to be cut was placed in the trough, and pressed, in small quantities, forward by means of a fork secured to the fore-end of the box by a chain, where it was cut off in determinate lengths by means of the knife, which the operator worked with one hand while he forced the straw, &c., forward, to be cut with the other. This plan will be recognised as the old well-known hand chaff-box, though now superseded by better contrivances; it was nevertheless an ingenious and effective machine.

The first chaff-cutting machine deserving the name was invented by Robert Salmon, of Woburn, many of whose inventions in connection with agriculture have since been adopted and carried out with great success. This machine of Salmon's was a large and cumbrous affair, but was, nevertheless, effective. It consisted in placing between the bellies of two wheels, and thereby connecting them together, a series of flat blades, the edges of which were fixed at an angle of 45 degrees from the plane of the wheel's motion. The knives in revolving are brought against the material to be cut at an acute angle, so preventing anything like a sudden blow. The straw was fed through a trough, and between two spiked rollers turned by ratchet wheels on the outside, and so arranged that the straw should be at rest while the knife was passing through it. It is quite evident that this is the original of a very large class of machines until very lately in common use.

Pasmore's engine was only a modification of Salmon's, which it considerably improved. In this case the knives were reduced in size, and the whole simplified, the feed better arranged, and the whole machine constructed in a much more mechanical manner.

*Lester's Machine.*—This was patented in 1800, and upon the principle now generally adopted, that is the placing the knife upon a fly-wheel. From this point, the chaff-machine has been rapidly improving: the earliest made had an endless web of cloth passing over two rollers, and carrying forward the straw, which was compressed by a heavy block of wood; both this and the endless cloth are now dispensed with. It was an effective engine, but consumed great power in working.

*Heppenstall's Chaff Engine.*—This was patented in 1818, and was on the same cutting principle as Lester's, but several improvements had been made in the feed; it consisted in the application of a worm to turn the two feeding-

rollers, which convey the straw to be cut to the two knives, which are placed upon two arms of the fly-wheel.

*Ransome & May's Chaff Engine.*—Lester's principle was entirely completed and carried out by Mr. May, and is thus described by Mr. Ransome in his valuable work, "The Implements of Agriculture:"—"The Chaff Engine patented by Mr. C. May is a successful attempt at combining the advantages of some of the older plans with the power of altering the length of the cut; and also avoiding the difficulty of supplying the material to be cut, so evenly, that it may be delivered at the mouth pressed so close as to stand against the knife. The alteration of this length is accomplished by adding a second shaft, placing the screw which impels the rollers upon one shaft, the wheel carrying the knives upon the other, and connecting the two by toothed wheels of varying diameters, and capable of change at pleasure; this produces a variable rate between the velocity of the rollers and the revolutions of the knife-wheel, and the hay or straw is cut into lengths proportionate to such variation. By means of a plate called the presser the material is secured close together, and this plate, in the patent engine, instead of being fixed to the support of the upper roller, has a motion round the axis of it; and thus, if the feed is thin, the presser follows down, or if thick, rises up, so that at all times the proper pressure is supplied." The parts being strongly constructed, a considerable velocity may be given to the wheel carrying the knives. This engine is the one from which all the modern machines have been more or less copied. Messrs. Ransomes have not been behind-hand in improving their machine; since its first introduction many important alterations have been made to make it cut inferior material, and prevent it choking, as well as to enable the machine to be run at a higher velocity.

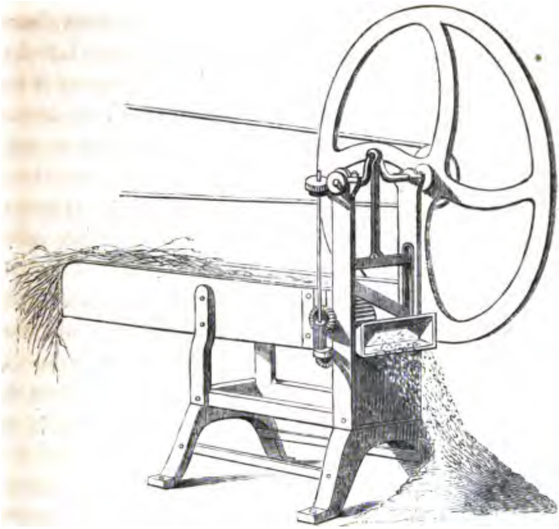
*The Uley Chaff-cutter.*—This machine was patented by Lord Ducie, in connexion with Clyburn & Budding,

engineers, of Uley. It is said to have performed its work admirably on the trial; its construction is thus described by the judges of the Royal Agricultural Society, Edinburgh: —"The cutter consists of two series of thin blades or knives, with serrated edges, coiled spirally round a horizontal rotatory cylinder, and presenting their edges at an angle to it; the one series is coiled from left to right, and the other from right to left, meeting in the middle of the cylinder: an unbroken continuity of cutting action is thus attained. A pair of feed-rollers is driven from the spindle of the cutting cylinder, which again gives motion to an endless cloth, by which the supply is maintained. The speed of the feeding-rollers is regulated by a highly ingenious and simple application of the worm and wheel. The wheel fixed on the roller is so constructed as to admit of being driven by worms, with threads varying from one to four; thus by changing the worm on the axis of the cylinder (which is also accomplished in a dexterously mechanical manner) the hay or straw is cut into lengths of from a quarter of an inch to one inch. This machine may be worked by manual, animal, or steam-power with equal convenience. Notwithstanding the favourable impression it made on first being introduced, it has not come into general use.

*Guillotine Chaff-cutter.*—This ingenious machine is the invention of Mr. Gillett, of Brailes, near Shipston-on-Stour, Warwickshire. (See fig. 38). It is a strong, well-arranged machine, and I have seen some that have been at work for a long time, giving great satisfaction: the whole machine is constructed of iron, runs very steady, and is exceedingly neat in appearance.

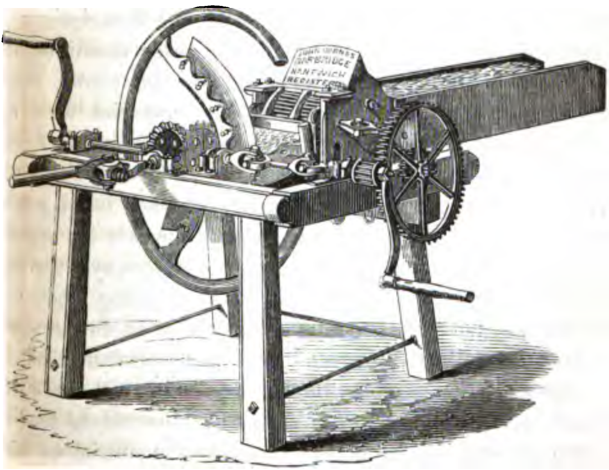
*Corne's Chaff Machine.*—This form of chaff machine seems to be preferred to all others; a great number of prizes have been awarded to it by the Royal Agricultural Society, as well as many local societies; it is manufactured under arrangement by several other makers, Messrs. Barrett,

Fig. 38.



GILLETT'S GUILLOTINE CHAFF-CUTTER.

Fig. 39.




CORNE'S CHAFF-CUTTER.

Exall & Andrewes, Hornsby, and others; it is fitted up with double gearing, to be worked either by two men or machinery; it cuts with three knives, breadth of cut 12 inches, depth 3½ inches, and makes one length of 4 inches for litter; a pair of rollers are also added to regulate the entrance of the material to the front rollers, next the cut, so getting rid of the danger likely to accrue to the persons feeding, by getting their hands entangled in the hay or straw when the machine is running at a high velocity. It cuts gorse or furze well $\frac{1}{8}$ of an inch long.

Richmond & Chandler make an excellent machine, with a most effective feeding apparatus, consisting of toothed rollers working into each other in such a manner as to ensure a regular feed, and prevent all choking; it is fitted upon a gothic pattern frame, securely made, and is in every respect an excellent machine.

Messrs. Barrett, of Reading, construct an exceedingly well-framed chaff-cutter, adapted to run at high velocities, entirely constructed of iron, and well arranged. The great difficulty in constructing an efficient chaff-cutter consists in getting it to feed equally well with all descriptions of material. A person unacquainted with these machines, and judging only from their performances at the shows, would be very liable to be deceived, as the material they are generally exhibited cutting is chosen for the special purpose, long, dry, crisp straw or clover; the very worst will appear effective when so employed; yet when badly got or damp hay is substituted it immediately makes its appearance where it should not, upwards and sideways, through the collar. If the machine is still kept going when this occurs, that portion of the machine which holds the straw to its work will be broken off, and as it is cast-iron cannot be repaired—the machine must remain idle till a new one is obtained from the maker. All badly-contrived feeding rollers will allow damp hay or any similar material to turn

round just before it is delivered to the knife, in passing round or between the feed-rollers and the end of the box; the reverse way, it meets the material coming in the opposite direction; a few turns more, and a general choke takes place; another turn or two, and some portion of the machine gives way. I have seen this happen over and over again when the common cheap machines have been attached to an engine of any kind, and an attempt made to run them at high velocities. If a large quantity of chaff is consumed, and the machine is to be worked by steam or water-power, it is always best to get a large well-framed machine adapted to the purpose. Such are made by all the principal makers, and if they guarantee them they may be relied on.

Messrs. Barrett have attempted to get a better feed in a totally different manner, by dispensing with the feed-rollers altogether, and substituting in their place a double endless chain, with circular bars extending across the box between the chains. The chains work over pinions at each end, and are in contact with the material to be cut their whole length, which is the improvement, as the rollers only hold between points. This machine was exhibited at the Smithfield Club Show last Christmas, and is the latest improvement I know of in connection with chaff machines.

It has long been a desideratum to have a machine that shall cut long lengths of straw for litter in an efficient manner; and though so many machines are advertised to do it, I do not see any that I could recommend for that purpose. I remember to have seen one a few years since, I think made by Smith, of Stamford, in which a moveable mouth-piece in front of the box carried forward the length of straw to be cut. This machine seemed to answer very well; but I have entirely lost sight of it, so I presume it did not answer. In Scotland, a machine is used for cutting straw, called the Canadian straw-cutter, and does its work very well;—two rollers, one plain and the other fitted with

knives, set lengthways of the roller, and radiating from its centre. These knives, as the roller revolves, press upon the cylinder below, and cut the straw into lengths equal to the distance between the knives. The feed is in the ordinary manner, through a box—the two rollers drawing it forward, without any other assistance.

I have heard this machine spoken very highly of as working very light, and cutting well; but I cannot consider the principle of cutting by pressure nearly so good as to give the knife a drawing motion, as is effected in every other machine. The lower roller must wear out rapidly, and there must be some difficulty in taking out the cutters to be sharpened or repaired.

### TURNIP-CUTTERS.

The general culture of the turnip in this country is of so late a date, that this machine must, of necessity, be one of recent invention. When turnips began first to be used as food for sheep, a peculiar shaped hoe was all that was employed to cut them up into small dimensions. When they became a part of the food of the fattening oxen tied up in stalls, or of cows, a sort of chopper was used;—two or three turnips being placed on a block, the upper surface of which was slightly bevilled, and the turnips chopped into irregular pieces, as they rolled down the face of the block. These turnip-chopping blocks are still used by some old-fashioned people in the upper parts of Norfolk.

There are three different forms of turnip-cutters in use at the present time; one is the placing knives on a disc; another, knives placed on a cylinder; and lastly, knives working through a grating by a crank motion.

In the first form, a series of knives are placed in the face of an iron disc by screws. The turnips are placed in a hopper set at an angle, so that they may press by their own weight against the disc.

The knives are of two kinds; one flat, and extending from nearly the axle to the outer edge of the disc, and at a distance from it equal to the thickness the slice of the turnip is required to be.

If only slices are required of the full breadth of the turnip at the part it is cut, then this knife is used by itself; but if it is necessary that the turnip should be cut into sections the cross way of the cut, as for sheep, then a series of small knives, projecting from the face of the disc at right angles, are placed at distances apart equal to the width required. The pieces, after being cut, fall into the receptacle beneath.

Sometimes the disc is set horizontally, and the hopper above. I have seen very good turnip-cutters constructed upon this plan. Occasionally the disc is attached to a barrow or a cart.

The turnip-cutter that seems to be most approved of is known as Gardner's, and is now manufactured chiefly by Messrs. Samuelson, of Banbury, and is shown in figs. 40 and 41.

Fig. 40.—Section through the barrel and hopper.

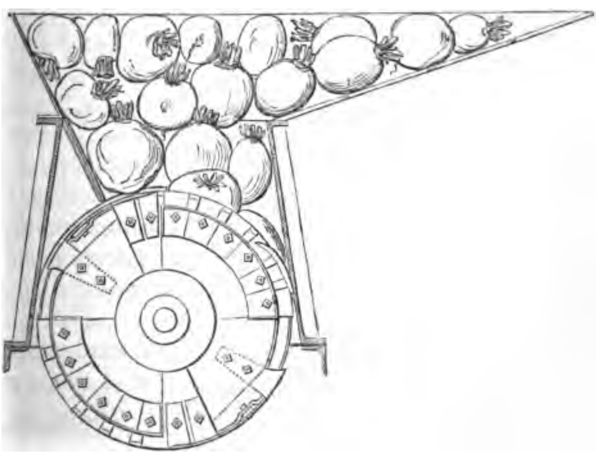
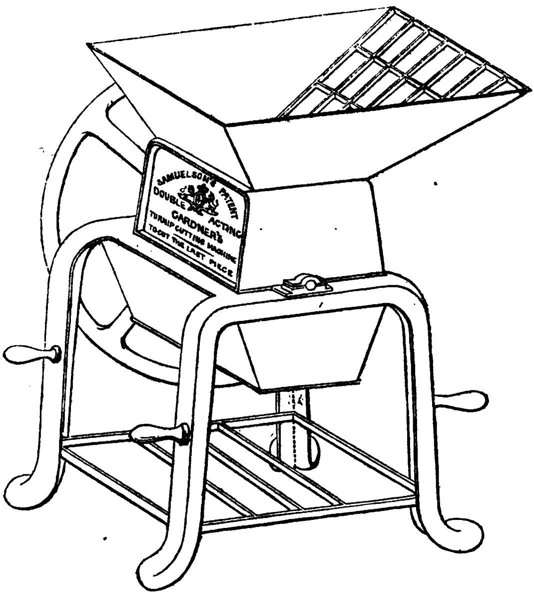


**Fig. 41 represents a general view of Gardner's machine; and fig. 40 a section through the cylinder and hopper, showing the cutting principle. Cylinder turnip-cutters**

Fig. 41.




SAMUELSON'S IMPROVED GARDNER'S TURNIP-CUTTING AND SLICING MACHINE.

were in use in Scotland long before Mr. Gardner's patent, but they only cut large and very unequal slices. The knife in them extended entirely across the cylinder with an unbroken edge, and had the cross knives placed under the slicing knife, of which there were two, and raised above the cylinder the thickness of the slice cut.

Gardner's improvement consisted in the arrangement of the face of the cutting-knife into sections of a width equal to the required cut of the root,—each knife cutting on the

front and side edge at right angles with it, and placed one above another till they meet in the centre, the angles of the knife retiring *en echelon* from the front to the centre. Two of these knives are placed on the cylinder in the cut, and against the front plate is shown a ledge, which causes the last piece of the turnip to be cut instead of falling through unslit. This is a recent improvement of the Messrs. Samuelson; and with some minor improvements in the detail, they have rendered it a perfect machine for its purpose; as it is a matter of great importance that the whole of the turnips should be cut into equal sized pieces, as nearly as possible, whatever the size may be, and not pass a large portion of thin edges or little angular pieces of slices; as when this is the case, great waste must, of necessity, ensue.

Messrs. Burgess & Key, of Newgate-street, are the patentees of a turnip-cutting machine, which I think an exceedingly good one. It is of very simple design, and is effective. It cut for sheep 3½ bushels in two minutes, at the trial of implements at the Great Exhibition, and was awarded a prize-medal. Two or three sizes can be cut at the same time, and each size be deposited in its separate receptacle; and a boy can work it.

All other roots, as mangold-wurzel, carrots, &c., and also chicory, may be cut with it equally well.

The principle upon which the machine acts is something similar to the machine formerly used in Scotland, and called the gridiron turnip-cutter; but only like in principle, as that was an exceedingly clumsy and rude affair, while this is an effective machine. In a long horizontal hopper are placed the turnips to be cut, and through the bottom of the hopper are a series of knives and guards, arranged to cut the different sizes. Motion is given by means of a crank to the knives in the hopper. This machine is well adapted for performing a large quantity of work in a short time; and is

not more expensive than other machines of the same capabilities.

### GORSE-MACHINE.

Gorse, whins, or furze, as it is occasionally called, is an exceedingly valuable substance as food for stock.

In the northern districts of Wales it has long been used as food for horses and other animals, and with milch cows the most satisfactory results have been obtained, as it imparts to the milk and butter a fine colour and rich flavour, and cows are said to be more profitable when fed with it, than with hay or turnips; but it is as food for horses that it is mostly used in Wales; it is said that in Carnarvon and Anglesey, and in a portion of the county of Denbigh, four-fifths of the farmers, innkeepers, and public carriers, who keep horses, are in the habit of using gorse as provender to a great extent, and with signal advantage.

Notwithstanding the acknowledged value of this plan, comparatively speaking, it is scarcely introduced in England as food for stock: occasionally some gentleman tries it, but tenant farmers generally have not adopted it, and chiefly on account of the difficulty of bruising the prickles of the plant, in which the nutritive juices are enclosed. In the localities mentioned, various plans are adopted, the most simple being that of the chopping block and mallet. The block is set up perpendicularly, and an iron hoop fastened round the top, above its surface, and about two-thirds round. The mallet is a round piece of wood nine inches long, and four and a half diameter; one end is armed with a knife, and the other end is studded with nails, the knife projecting from the wood about three inches; both ends are secured by an iron band. The gorse is placed upon the block and chopped with the mallet into short lengths, after which it is bruised with the other end of the same instrument.

Another plan, on a larger scale, is to subject the gorse to

the action of edge stones, similar to a cyder mill. The gorse is most effectually bruised by this means. A regular mill is sometimes constructed in the following manner, and similar to a bark mill. Three or four rows of strong angular pieces of wrought-iron are fixed in a horizontal shaft; the rows are generally from two and a half feet to three in length; the teeth in the rows are about six inches long, clear of the shaft, which is placed inside a strong wooden box, formed of three wooden beams, each fitted with a row of teeth, similar to those on the shaft between which the latter pass as the shaft revolves, crushing the gorse most effectually, by reducing it to a pulp.

Wedlake's gorse-machine is very like this, only on a small scale. Decidedly the best machine hitherto invented is the one manufactured by Barrett & Exall. I have tried

Fig. 42

this machine myself, and can testify to its thoroughly accomplishing its purpose, the gorse, after having passed through, being quite soft like moss, and cattle that may

never have tasted it before eat it without the least inconvenience. Fig. 42 represents the exterior view of the machine; in its action it first cuts the gorse as chaff, by means of six knives placed on a drum, and afterwards compresses it between two rollers.

*Potato-Separator.*—This is a machine used for the purpose of separating potatoes into sizes ready for sale, and used for the different purposes to which the root is applied.

It is an exceedingly useful machine on those farms where potatoes are largely grown, and getting them properly sorted will ensure the farmer a greater profit than selling them mixed large and small, as the difference of price is greater for the superior class than is allowed for to the grower, a profit being always afterwards made by sorting, which ought to be got by the farmer.

Potato-separators have usually been constructed with three sieves or screens of different sized meshes, placed one under the other with a shoot to carry the potatoes from each screen to a separate receptacle; but Mr. Daintree, of Somersham, Huntingdonshire, has introduced an entirely new description of machine, exceedingly simple in its action, as, by one simple rotatory motion, which can be performed by any boy or woman, the potatoes are separated into three sizes, with much greater regularity than can be effected by any other means. The screen will entirely free them from all dirt, straw, or any other rubbish.

*Root-washing Machines.*—If machines are not provided for this purpose, the general business of the steading will be found to be conducted in a slovenly manner, as I know of nothing more indicative of it than to see stock feeding from roots covered with dirt; yet how often is it the case! Look at the state of the potatoes preparing for the hogs in many farms. Does the feeder imagine the animal is to get fat on dirt?

An ordinary practice is to put the roots into a large tub

filled up with water, and with a stick stir them about. It is true roots *may* be thoroughly washed by this means; but it is equally true they *never are*. There is no use doing the thing badly when such capital machines as those constructed by Richmond & Chandler and Crosskill are to be got at moderate prices.

Richmond & Chandler's machine consists of a cylinder formed of narrow bars, into which the roots are placed; the cylinder is supported at each end of an iron water cistern, in which it revolves by the action of a winch at one end. A portion of the cylinder is moveable, for the purpose of admitting and withdrawing the roots. At each end of the water trough is a rack set at an angle of forty-five degrees, and near the top of this rack it is curved nearly to the horizontal.

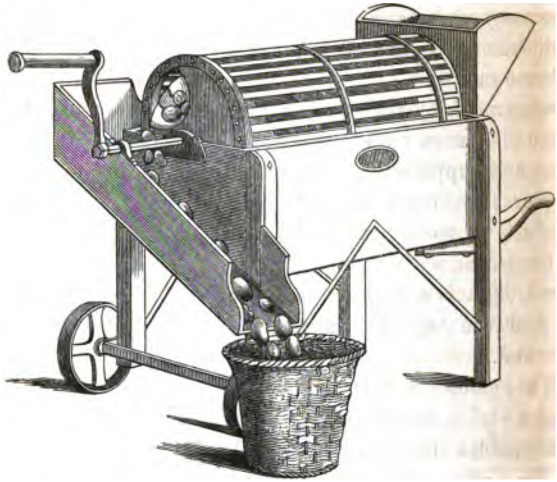
On the gudgeon that supports the cylindrical washer is placed a pinion, which gears in the rack. A simple arrangement enables the operator (after he has revolved the cylinder sufficiently often to cleanse the roots) to strike in gear the pinion with the rack; the cylinder is then lifted up to the horizontal part of the rack, where it remains while being emptied into a trough or barrow.

*Crosskill's Archimedean Root-Washer.*—This is an exceedingly ingenious and simple root-washer, and does equally well for seed, corn, Egyptian beans, &c., when provided with a perforated cylinder. Fig. 43 represents this machine; it consists of a cylinder similarly constructed to the one we have described by Richmond. In this cylinder is placed a spiral chamber, against which the roots press while being washed, which is done by a winch turning the cylinder in a water tank; when the roots are cleansed the motion of the cylinder is reversed, and the roots pass through the spiral into a shoot, as shown in the woodcut.

The two legs at one end of the cistern are placed upon wheels, and at the other are two barrow-handles, thus

enabling the machine to be removed from place to place with extreme ease.

Fig. 43.



CROSKILL'S ARCHIMEDEAN ROOT-WASHER.

## APPARATUS FOR COOKING FOOD FOR STOCK.

The advantages of cooking the food of animals are so well understood now, that a steaming apparatus is considered indispensable to every well-ordered steading. The process of boiling or steaming is known to effect great and important changes, both in the chemical and mechanical condition of food, and to render many substances suitable for the digestion of animals which, in their raw state, are indigestible or unwholesome. The mechanical division of boiled food facilitates the acts of mastication, swallowing, and ruminating (in ruminating animals).

Hence it naturally results that cooked food is more economical, as digestion being more perfectly performed a less quantity of food will suffice to produce the increase of

weight in the animal. The boiling of the food of animals is one of the best known means of promoting digestion; it also increases the quantity as well as the quality of the alimentary substances which undergo the process. This advantageous result appears to originate in part from the circumstance that the molecules of the alimentary substance are separated by the coction which they undergo, and thus present a greater surface to the influence of the gastric juice, and partly from the influence of the water in which they are immersed, as well as the high temperature to which they are exposed, augmenting their nutritive powers. The water seems actually to become solid, as in the making of bread, by entering into union with them, or by imparting its hydrogen, which afterwards, uniting with carbon, contributes greatly to the formation of fat.

The ordinary apparatus used for steaming food for stock, consists of a copper or boiler for generating the steam, and a receptacle into which the food is placed to be acted upon by the steam.

The boiler is made in a variety of ways, it being only necessary to construct it of sufficient strength to bear a pressure of about two pounds to the square inch. Sometimes the boilers are made spherical, at others cylindrical, and often a small waggon-shaped boiler is used. In steadings of large size, where a fixed engine is used, the boiler employed to generate the steam for the engine, should also supply the coppers for cooking the food. In small farmeries a complete apparatus for steaming may be purchased adapted to the size of the holding. Several of these are now manufactured by different houses, properly constructed for the purpose. Among these, Stanley's seems to be considered one of the most complete: it consists of a portable steam-generator, a strong oak compound tub, with copper or iron inside lining, and a six-bushel vegetable-pan. It is fitted complete, with force-pump, water-gauge, unions, and pipes.

The vegetable-pan is a cylinder, supported in the centre on each side. Through one of these bearing-trunnions the steam is admitted. This manner of hanging is to enable the pan to be tilted, so as to discharge its contents into the pails or barrows, in which it is carried to the stock.

A neat and convenient apparatus is manufactured by R. Robinson, of Belfast; the boiler being a cylinder standing on four short legs; in this cylinder is placed the furnace, and above it a vase-shaped vessel for supplying water. The vegetable-tub is placed on a barrow, so that it can be removed straight to the stock after the food has been cooked. This machine is well adapted for cooking out of doors, as the whole apparatus may be removed from one place to another with great facility. Messrs. Richmond, of Salford, received a medal at the Derby Meeting of the Royal Agricultural Society, in 1843, for a very complete steaming apparatus, particularly recommended for its fittings, as regards safety, supply of water, &c.

A variety of plans are in use for steaming and cooking food, but the kind of apparatus we have described, as made by Stanley, Richmond, and others, is so superior to all others, that it is not worth while describing them.

## CHAPTER XI.

### CHURNS AND THE UTENSILS OF THE DAIRY.

*The Churn* is a machine for agitating milk and cream, by which means the butyraceous matter is separated, and butter produced.

The simplest and oldest form in which churns are made is in the form called the conical cottage dash-churn. This is constructed by the cooper, and consists of a long narrow

tub, tapering upwards to allow of tightening by hoops; it has a lid, and in that a small central aperture, through which works a staff or handle; on the bottom of this, inside the cylinder, is a round disc of wood, with a number of holes cut in it, or else it is made of separate bars. The diameter of the disc is something less than the upper diameter of the cylinder.

The simple motion perpendicularly of the handle upwards and downwards works the piston, or perforated board, at the bottom, through the cream, and agitates it sufficiently to cause it to throw up the butter in lumps. It is taken from the churn in this state, and made up to lumps for market, or placed in casks with salt. This description consumes considerable power when worked by hand, and is slow and tedious.

In large dairies, the churn employed is usually a barrel (not bulged in the middle), having in one end a hole, through which the cream is admitted, and the butter extracted. Over this hole is a plate of metal or wood, which can be screwed down to the head of the barrel,—a piece of leather or cloth being first placed between the parts, in the centre of each head of the barrel are securely and accurately fixed two gudgeons or spindles. These are placed in proper bearings set upon a strong frame, and on one end of the gudgeons, or both, are placed winches, by which the barrel may be made to revolve. In the interior of it, parallel with its axis, and secured to it, are pieces of board radiating from its centre. These agitate the milk sufficiently, as the barrel is turned.

The chief defects of this machine are a too great tendency to carry the milk round with the barrel, and the difficulty of getting at the interior to properly cleanse it after churning.

Another barrel-churn is made by causing the barrel to remain stationary, and placing a shaft through its centre, upon which the dashers are placed. The operation is much

the same, except that in the one case the milk is worked against the dashers, while in the other the dasher is worked against the milk.

*Box-churns* are similar in their action to the one just described, except that they are four-sided, while the other is cylindrical. These are made in immense variety, the difference of the shape of the dasher being the chief cause of the variety.

The ordinary old box-churn dasher consisted of eight arms fixed upon a spindle, four on each side of the box, the arms radiating from the centre, and placed at right angles to each other; between these arms are placed narrow flat pieces of wood, generally three in number (in the small hand-churns), the spaces between them and their width being equally divided. The spindle passes through the centre of these arms, and gives motion to them by means of a winch-handle outside. One end of the spindle works in a bush let into one side of the box, and the other nicely secured from leakage by means of a plate secured to the top of it; the bearings of the spindle are generally made of ivory, as brass bearings would taint the cream. Churns of this description are made of all sizes, suitable to the extent of the dairy for which they are intended. A churn has been introduced in Ireland, and considered as a great improvement upon this. It consists in placing round the lower part of the box a water space (the box being made of metal in the lower part, and semicircular in form); the ends are of the ordinary woods, as birch or palm-tree. The water in this outer case of the churn is employed to regulate the temperature of the cream. It is supplied to the reservoir by means of a funnel, and a tube passing down the side of the upper part of the box; it is covered with a lid like the ordinary box-churn. One peculiarity of this machine is that the spindle passes through this in the direction of its greatest dimension, while in the others it is through its

shortest. The regulating-bars are here round rods instead of flat spars. The whole is mounted on a metal frame, and has a compact and handsome appearance. An exceedingly elegant and good churn is described in Stevens's "Book of the Farm," as being originally invented by the justly celebrated Mr. Wedgwood, though lately brought forward as a new invention.

This containing vessel is still formed of the Wedgwood stone-ware of the strongest white glazed kind, and has a varnished wooden cover; the outer case is made of sheet zinc: both inner and outer cases are cylindrical, and an ample space is left between the two. In the inner cylinder is placed a vertical spindle, upon which the dashers are placed; these are three vanes of wood or metal nearly the whole depth of the churn, and having perforations through them; on the top of the spindle is sometimes placed a horizontal wharve or pulley, and the machine is put in motion by means of a bow-string. This is effected in the same manner as a watchmaker works his drill, the bow being bent until the string is sufficiently slack to enable it to pass once round the pulley; the bag is then allowed to expand outwards, and being then pulled backwards and forwards, gives a motion of considerable velocity to the spindle. This motion being reversed, is highly favourable to the producing the butter.

As a substitute for the bow-string (which is not the most easily managed means for giving motion, unless for exceedingly small machines), there is placed on the top of the spindle a mitre-wheel or pinion, and supported by an iron frame; on a cross-shaft is another larger mitre-wheel which receives motion from a crank or winch, the motion being reversed every second revolution.

Mr. Stevens gives the following result of an experiment made to ascertain whether the alternate motion might not be dispensed with:—

"In the plane cylindrical vessel, with the agitator always moving in one direction, butter was obtained in fifty-five minutes. In the same vessel, with the agitator moving alternately right and left, at every two revolutions, butter was obtained in twenty-five minutes.

"In this same vessel, fitted as above described, with counter agitators, but with the agitator moving in one direction only, butter was obtained in twenty minutes. From these results it appears that, even with a cylindrical vessel, if properly armed, the process is performed in a shorter time than with inconvenient reversed motions."

A peculiar churn is noticed in Lambert's "Travels in the United States and Lower Canada:"—

"At a farmer's near Lake Champlain, we saw a machine for churning butter. It was a kind of half-barrel, with a place where one of the farmer's sons sat astride as on horseback. The machine, moving up and down, answered the double purpose of a rocking-horse for his children, and a machine for making butter."

The Lancashire churn is considered to be a good one, and is worked with a cord similarly to the bow-string churn; but in this case no bow is used, a triangular frame of wood being substituted in its place; one angle works in a gudgeon on the ground beside the churn, the other two angles have secured to them the cord which passes round the top of the staff, there being no pulley as in the other. The operator stands with one foot on each side of the triangular frame, and throws his whole weight alternately from one side to the other; the cord is thus made to wind up the dasher as well as turn it round, thereby producing a compound motion, combining both the action of the box-churn and the old vertical acting dash-churn.

The Derbyshire churn is a combination of the barrel and box-churn, the dasher working similar to that in the box-churn, but is composed of flat boards with holes through them.

A great deal has been said of late about American churns, and the great improvements effected in them; they are of two kinds, Antony's Cellular Agitator or Dasher, and Dalphin's, with a curved moveable piece attached to a cellular dasher.

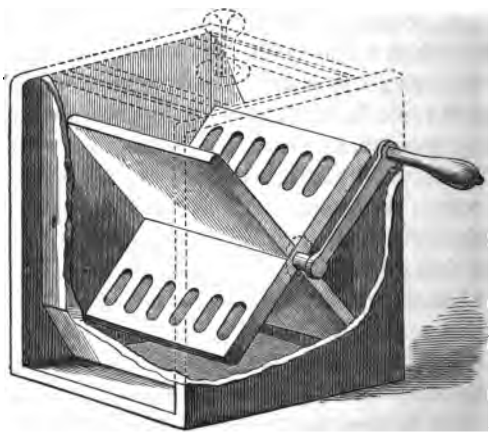
In Antony's churn the dasher is a flat board, having a piece of wood running all round the edge of it, and projecting about an inch above it; between these raised sides are cross pieces, four in number, of the same height as the rim-pieces, thus dividing each side of the dasher into five divisions or cells, the middle one being considerably the largest. The advantage of having these cells is to carry down into the cream a quantity of air, and the cross-pieces produce a better agitation than the ordinary bars of the box-churn.

Dalphin's churn is also a cellular churn, the backs of the cells being curved instead of square, as in Antony's; but the principal difference is the having a moveable piece turning on a centre at each side of the dasher. It is said to offer a peculiar resistance when the butter is first forming, which greatly facilitates and increases its production when turning; the cream is agitated by meeting with the slats of the dasher, which are set at such angles as to force the cream towards the centre; it is then met by the moveable floats, which when revolving stand open, and cause the cream to move outwards, which various and contrary motions so agitate it, that the butter is soon produced. The proprietors of this churn say, that without removing the butter, and with the same motion, it will perfectly separate every particle of buttermilk from the butter, wash it in clean cold water, work in the salt evenly, and turn it out a solid mass of pure butter. The arrangement of the dasher is such as to allow of its being turned with great ease, and bring the butter in a very short time; reversing the handle, that is turning in the opposite direction,

causes it to gather the butter and work out every drop of buttermilk.

In very large dairies it is necessary to have churns of large size, to be driven by horse-gear, water-wheels, or steam power. All the churns we have described may be constructed of large dimensions, but the arrangements for giving motion to the dashers become then a matter of importance. Messrs. Richmond & Chandler have produced a churn for large dairies that is I think the best I have ever seen; its superiority consists in having a double perpendicular action, by which the plunger of the downward stroke forces the cream through the middle partition, following the upward plunger, so that at the reversion of the cranks, the cream is met by the plungers and forced backward and forward in rapid succession, "crasing" and agitating it in a few minutes into small particles of butter; after which, by slowly turning the crank, the small particles adhering to each other quickly become in a condition to be taken out.

Fig. 44.



Tytherleigh's patent barrel-churn is considered a most excellent one; it is in use in her Majesty's dairy at Windsor, and has given the greatest satisfaction.

*Curd-Breaker.*—This machine is used for breaking the curd in the manufacture of skim milk, cheeses, &c. It consists of a hopper of wood 17½ inches by 14 inches on the top, and 10 inches in depth, and a cylinder of hard wood 6¾ inches in length, and 3½ inches and a half in diameter. The cylinder is studded with square pegs made of hard wood, each a quarter of an inch in the side, cut square at the ends, and projecting three eighths of an inch. There are eight teeth in the length, and fifteen in the circumference of the cylinder, 120 teeth in all. It revolves on a round iron axle 12 inches in length, and is moved by a crank handle; there are two wedge-shaped pieces of hard wood, made to fill up, in some degree, the space between the side of the hopper and the cylinder. These pieces rest on a slip of wood nailed to the lower rim of the hopper, to keep them in their place. The face of these is studded with nine teeth of hard wood, similar to those on the cylinder, at opposite sides. The stand can be made of any length, to suit the breadth of the tub into which the curd is broken. The implement is used in this manner:—Place over it a tub, heap the hopper with curd, and, on turning the winch in either direction, the curd will fall, broken quite small, into the tub. While one hand is moving the machine, the other can press the curd gently down into the hopper. As cleanliness is a matter of the greatest importance in cheese-making, the internal parts of this machine, being loosely put together, can be easily taken to pieces to clean. The cylinder axle rests on two hard wooden blocks, one on each side, which slip out of their groove. They are held in their working position by the thumb-catch sunk flush with the bottom of the stand, one over each block. The wedge-shaped pieces come out. To prevent the

curd working out of the sides of the axle, the cylinder is set a little at both ends into the sides of the hopper.

*Cheese-Presses.*—A variety of contrivances are used for this purpose, but they are all similar in their action, the object being to place a heavy weight on the forms of curd, which weight shall descend regularly down after the cheeses as they decrease in bulk, from the whey being expressed from them. The old form of cheese-press was usually a heavy weight of stones placed in a box, which was raised either with a screw, or cords and pulleys. The more modern cheese-presses act by the action of levers instead of weights, or by pneumatic pressure. Baird's press is one of the best in common use, and is described in the Highland Society's Transactions. It consists of a circular bed-plate, supported on four curved legs; from each side of this bed-plate, two circular iron columns are fixed to support a cross piece, through which passes a bar of iron, one side being formed into a toothed face or rack. On the lower end of this bar is placed another circular plate having two ears, one on each side, with holes in them, through which the two perpendicular rods before mentioned pass; this second plate corresponds with the former one in size, and it is between them that the cheeses are pressed. On the cross piece is placed a pinion which acts against the rack; a lever is placed in such a manner as to act upon the pinion according to the force employed, by placing a weight upon the lever at suitable distances from its fulcrum. Cheese-presses upon this principle are made by a variety of manufacturers.

An improvement upon this press has been made by Thewlis & Griffiths. In theirs, the facility for making and pressing cheese is secured by means of a pair of bevil wheels, and a treble pitch screw, regulated by a self-acting lever and weight, whereby a pressure of upwards of two tons may be obtained.

Robinson's Pneumatic Cheese-Press is thus described in

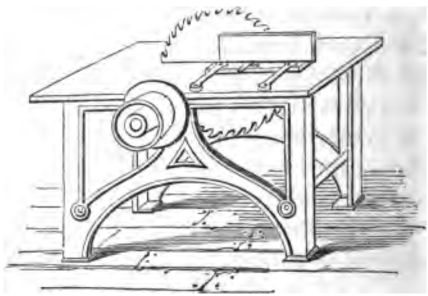
the Highland Society's Transactions. When of full size, this press may consist of a stand about three feet high, on the top of which may be fixed a tinned copper or zinc vessel of any required capacity (say 18 inches diameter, and 18 inches deep) to contain the prepared curd. This vessel should have a loose bottom of ribbed work, covered with wire-cloth, from under which a small tube nearly twelve inches long, should communicate with a close vessel, capable of containing all the whey which may be drawn from the curd in the upper vessel. At one side of the stand there may be a small pump-barrel of about seven inches deep, from the bottom of which a suction pipe should terminate at its upper end in a valve opening upwards, and a piston with a similar valve should be placed in the pump-barrel, and be worked by a jointed lever. The process is to be conducted as follows:—The curd being prepared, and salted in the usual way, a cloth is to be put over and into the upper vessel, and the curd put lightly into it, except round the edges, where it should be packed quite close to the sides of the vessel, so that no air may pass that way; the pump handle is then to be briskly worked for a few minutes, on which the pressure of the external air will force the whey to run down the tube into the whey-vessel; when it ceases to run, a few strokes of the pump may be repeated. The cloth and its contents are then to be lifted bodily out of the curd vessel, and to be put into a mould of close wirework, with a weight placed over it until it become firm enough to be handled. The mould should stand on a sparred shelf (a shelf made of laths like a bacon-rack) to allow the air free access to it on all sides of the cheeses.

# CHAPTER XII.

## CIRCULAR-SAW BENCH.

THIS machine is indispensable to every large farm;—sawing being a most expensive description of labour when performed by the regular sawyer; and the large quantity of sawing required to be done on a large farm renders the fitting up of a saw-bench a positive economy, as the motive power of the steading may be employed to drive it; and fencing, as well as nearly every other description of sawing, may be performed with it, and at a comparatively trifling cost.

Fig. 45.



CIRCULAR-SAW BENCH.

Fig. 45 represents a small saw-bench, adapted to farm purposes, the framing being entirely of iron. They are generally made of wood; and if the steading is being built new, and the timber-work constructed of the timber grown on the estate, as is often the case, the bench had better be of wood. It is constructed in the following manner:—An exceeding strong wooden framing is prepared, about 8 feet

long, and 4 feet wide, and about 3 feet 6 inches from the ground. The timber must be of great strength, and very securely framed by tenon and mortising, and strong iron bolts passing from side to side, tightening up against countersunk iron plates. The framing must be supported by diagonal pieces tenoned into the centre of the upper rail, and into the posts and lower rail. These diagonal pieces are sometimes omitted, but when they are, the bench will be sure to become rickety, as it is impossible to construct frames of machines, that have to resist great strains, like a table on four simple legs. Near the centre of the table, in the direction of its length, is placed and sunk, so that its upper surface may be exactly level with the surface of the table, an iron plate. In this plate is a cut or slot, or half the iron lengthways is moveable. Under the bed-plate, crossways of the table, is placed a strong iron shaft or spindle, supported on two plummer blocks. On one end of this spindle are two pulleys, the one fixed to the spindle, and the other running loose upon it. At the other end of the spindle is a disc of iron, having a perfectly flat face; a small piece of the spindle projects through the centre of this iron plate, and upon that is placed the saw.

The saws are flat circular plates of steel, having teeth cut upon their outer edge. They are made of various sizes, from 10 inches diameter to 4 feet, the teeth being cut large, and shaped for ripping up large stuff, or small for cutting joiners' wood.

The saw has a hole in the centre exactly the size of the turned end of the spindle upon which it is placed; and another disc of iron is screwed upon it, pressing it and holding it securely against the other, and in its place, so as to run perfectly true. The moveable portion of the bed-plate is then replaced, and rather less than half the saw appears above the surface of the table. A strap from some portion of the machinery in motion is placed upon the loose

pulley on the spindle when the saw is required to be used; the strap is pressed towards the fixed pulley, which, from its shape, immediately runs upon and gives motion to the saw. It is necessary that the saw should revolve with immense rapidity, or it will not be effective.

To enable the sawyer to use this saw when so revolving, it is necessary that some means must be contrived to enable him to secure the piece of wood he is cutting from moving out of a straight line while the saw is passing through it. This is effected by a guide-plate of wood or iron, placed exactly parallel with the line of the saw. At the back of this is another plate, also perfectly parallel, and from one to the other extend bars of iron, moveable at the points, where they are held exactly the same as an ordinary parallel ruler. The guide-plates may by this means be brought close up to the saw, or removed ever so far back towards the points. In the wood-cut there is no plate at the back, the radius bars being fixed to the table, the guide-plate being set to any fixed distance from the line of the saw, and secured by screws in that position. The piece of wood to be cut is placed upon the table, and moved against the cutting-edge of the saw, while at the same time it is pressed firmly against the guide-plate. Being kept in this position while gently moved forward, the saw will, of course, pass through it in a perfectly straight line, cutting off a piece of exactly a thickness equal to the space between the guide-plate and the saw.

## CHAPTER XIII.

### VERMIN, AND THE METHOD OF DESTROYING IT.

Of vermin that infect the steading, the rat is by far the worst, and the most common.

The rat usually met with is the domestic rat of Norway, or gray rat, which has almost entirely extirpated the indigenous black rat. To get rid of him is an exceedingly troublesome affair. The best way is to prevent his coming, or rather taking up his abode; and this may be done by constructing the building in the manner described in Vol. I., so as to prevent, as much as possible, his travelling about on the top of the walls, and under the floors. An immense variety of plans are resorted to to catch and kill these animals: by poison laid about for them to eat, by traps set at different places, or by a rattery regularly constructed in some particular situation, and by employing animals, as dogs and cats, to catch them.

Of the different plans, the following appear to me to be the best:—Fry a piece of sponge or cork in butter; then compress it between two plates; afterwards cut it in little pieces, and lay it about for the vermin near the holes they frequent. They will eat it with avidity; and as it excites excessive thirst, they will drink water, which immediately swells the fried sponge, and kills them.

Plaster of Paris, mixed with barley-meal and salt, is said to produce a similar effect.

Rubbing their holes with Stockholm tar soils their coats, and puts them to such inconvenience, that they will leave the place. Mixing barytes with water produces such intense thirst, that they will seek water immediately, and die the

moment they drink. Poisoning their food with arsenic, and mixing treacle and arsenic together, and smearing their holes with it, is found to be effective.

A variety of other poisons are used; but they are all dangerous to the other animals about the steading, and had better not be used if possible.

Rat-traps are made in great variety; but these soon acquire the disagreeable odour peculiar to rats and mice; and after that is the case they will not enter them.

The best plan is to have good cats, well kept; for they will be more effective in clearing vermin when in good condition than when half starved. They should be regularly fed every day, like any other animal; and they will keep the interior of the buildings clearer of both rats and mice than any traps or poisons could effect.

## CHAPTER XIV.

### SCIENTIFIC INSTRUMENTS.

The class of persons into whose hands the farm lands of this country will soon pass will possess such a superior amount of intelligence that the most scientific operations will be accurately performed, and all the benefits of a scientific knowledge rendered available.

The use to any extent of philosophical instruments by the old class of agriculturists was out of the question; but there is no reason now why those who have the management of large and valuable farms should not be as well able to use a scientific instrument as those who have the management of large merchant ships, as there is no doubt but the agriculturist may derive considerable advantage, and his judgment be materially assisted, by the use of them.

It is well known that the weather effects a sensible power in retarding or accelerating field operations. It is therefore positively incumbent on the master of a farm to make himself as thoroughly acquainted as he can with the principles which regulate the phenomena of the atmosphere, so as to enable him to form as correct a judgment as possible of what weather to expect when about commencing any particular operation. To aid him in this, he will require the following instruments:—A barometer, thermometer, hygrometer, rain-gauge, and a weathercock, fixed in some position where it may be easily observed, and not affected by local currents and eddies of wind.

The barometer is an instrument for determining the weight of the air, and the variation of its pressure under different circumstances. It was invented by Evangelista Torricelli, a pupil of Galileo, whom he succeeded as teacher of mathematics at Florence. He calculated that the same cause which raises water 33 or 34 feet high (a fact which Galileo had previously discovered) should raise mercury, which is fourteen times heavier, only 29 or 30 inches; and his experiments proved the correctness of his theory, that the column of mercury was supported by the pressure of a column of air resting on the mercury in the tube, and extending upwards to the limit of the atmosphere.

Torricelli, in constructing his first barometer, closed a tube of glass hermetically at one end, then filled it with mercury through the other; and upon inverting it in a vessel containing the same material, he found the mercury descend in the tube, and remain 29 or 30 inches high. The space in the upper part of the tube unoccupied is called the Torricellian vacuum.

Barometers adapted for judging of the weather are made in a variety of forms; but the two in general use are either an upright column of mercury, with a graduated scale, or what is called a wheel barometer, which has a face, with

hands pointing to a graduated circle, and marked rain, fair, &c. The latter plan, though most commonly used, is not so good as the upright tube, as there is considerable machinery to be put in motion by the mercury to indicate the change on the circular face; this must naturally lessen the delicacy of the indication.

The tube of the barometer is a most important matter. It should be perfectly true and cylindrical, about 33 inches in length, and the bore must not be too small, which it in nearly all cases is, to save mercury; for when it is so, the friction and capillary attraction will affect the free motion of the mercury up and down the tube.

The mercury should be carefully freed from all foreign metals. Common mercury is greatly adulterated with tin, lead, and bismuth.

In observing the mercury, if the upper surface in the tube is convex, it is about to rise; if concave, to fall. The scale is usually graduated to the level of the sea; that is, the mercury rises the lower it descends towards that level, and falls as it is removed to greater altitudes. Should a farmer possess an instrument so graduated, and he reside up in some hill country, the mercury would not indicate truly according to the figures and writing on the scale. It is therefore important to register the actual fall and rise of mercury, and judge by that more particularly.

The indications of the barometer are thus:—When the mercury is high and remains so, good weather; a gradual and equal fall is indicative of rain, and the more rain if the wind is east of south. Sudden changes of the level of the mercury indicate similar change of the weather; and sudden falling of the mercury to any extent surely indicates gales of wind and storms. We have not space in this little book to point out all the various peculiarities of the instrument, and the changes it is liable to. The observer should study some scientific work which treats of the subject at length.

The thermometer is an instrument for measuring heat, on the principle that the expansion of matter is equal to its augmentations of temperature. A variety of materials have been used in the construction of thermometers—water, alcohol, and oil,—but mercury approaches more nearly to solids in its rate of expansion, and remains liquid through a longer range of temperature; it is, therefore, adopted as preferable to all others. A common thermometer is merely an instrument in which very minute expansions of the mercury are rendered perceptible. This is effected by filling a glass tube with mercury, in a similar manner to what we have described for the barometer, and attaching to it a graduated scale. Common thermometers are exceedingly inaccurate, in consequence of the irregularities of the inside of the tube. The scale, which is placed by the side of the tube, should be graduated, to allow for the inequalities, if for any very minute purpose; but as no very accurate observation is required by the agriculturist, an ordinarily constructed one will be sufficient. They are exceedingly cheap; and all cattle-feeding houses should be provided with one, and an equal temperature be preserved.

## CHAPTER XV.

### THE RICK-YARD.

In the rick-yard will be required to be placed frames, or beds of some kind, upon which the stacks are to be placed, and so constructed that vermin be not able to get at the grain, which it will most assuredly do, if no means be taken to prevent it. Sometimes a circular wall is built, with a projecting coping; but the usual plan is to construct stack-stools or staddles. This is done by arranging as supports, at

distances according to the size of the rick, a series of stone or iron pedestals, conical in shape, and having on the top a cap of the same material, but of considerably larger diameter, called the bonnet,—the outer edge of this cap stone being so far removed from the upright piece, prevents the possibility of vermin being able to mount to the frame that supports the stack.

These staddles are now made of iron by all the implement manufacturers, at a reasonable price; and are by far the best things for the purpose. An excellent description is made by Messrs. Garrett, of a circular form, and of three rings, one within the other. The supports are small wrought iron columns, resting on square bases, and surmounted with hollow conical caps. It is impossible for vermin to reach the rick when it is thus protected; and a free current of air being secured through, the corn is hardened and dried better than by any other plan.

Deane, Dray, & Co., make an excellent rick-stand, square, upon cast-iron legs, with conical caps, and supporting a square frame.

The rick-yard should be enclosed with a good wall, and be trimmed to an even surface. For the plan of arranging the ricks, the reader is referred to Vol. I., p. 82. A rail or tramway should be laid down, for facilitating the removal of the ricks to the thrashing-barn, and the removal of straw back to the rick-yard, should it be thought necessary to restack it, after having passed through the machine, as is often done. For the manner of constructing the railway, see article on farm railways, in Vol. III. of this work.

*The Rick-yard Truck.*—A variety of contrivances have been made for removing the straw in the rick-yard; sometimes the stacks have been constructed on staddles which had wheels, and the whole rick was to be bodily moved up to the thrashing barn, but this is an exceedingly difficult plan to carry out, and would take up a great deal of room, and require a great

length of railway to be laid down. That there must be a railway is agreed on all hands, and the only difficulty is, that the stacks must be arranged on either side of a straight line of rails, which would be impossible in many cases, and exceedingly inconvenient in others, or, a considerable expense must be incurred in having turntables at each junction of cross line, so as to get at the ricks from the main line; now as these turntables would be very expensive in the first cost, and would only be used perhaps twice a year each, it is evident that the increased cost of carrying the ricks by the ordinary means of carts and waggons would be preferable to allowing a large sum to lie idle in the shape of turntables, only to be used once or twice in a year; some means must therefore be devised to keep the lines crossing each other at right angles, and get rid of the cost of turntables. This has been done in two ways; first by Mr. Morton in the following manner.

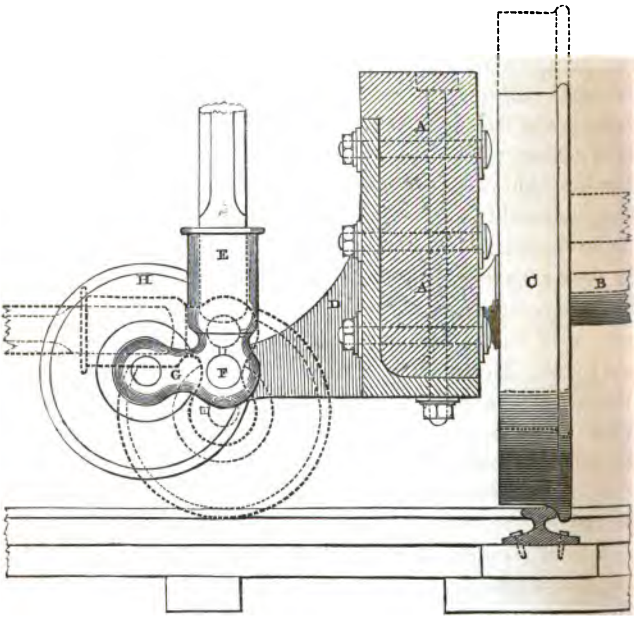
Between the principal lines of ricks is a sunk road with a line of rails upon it, and upon this is placed a truck; upon this truck is placed crossways, a pair of rails, fitting with those on the cross lines; a truck being laden at the side of the rick on the cross line, it is run along till its wheels are on the cross rails of the truck on the main line, and which we before stated is in a sunk road. The truck laden from the cross line, upon the truck on the sunk line, are then together run up to the thrashing-barn. There is no doubt but this plan answers very well, its objection only being the expense of two trucks instead of one, and the cost of making the channel in which the sunk truck runs. I question whether much is saved from the cost of turntables.

The other plan is one I have myself invented, and which I think gets over the whole difficulty. It is by having a truck so constructed, that it will pass from one line to the other without the aid of a turntable.

Fig. 46 represents a portion of this truck, showing the

manner in which the wheels are arranged to work on both lines: A is the side frame of the truck, B the axle, upon which is placed the wheel, C an ordinary flanged railway

Fig. 46.




wheel; there would of course be four of these wheels on two axles, as in any ordinary four-wheeled truck; beside the frame outside, is placed a cast-iron carriage D; in this carriage works the foot of a moveable lever E, upon a pin F, through cheeks; at the bottom of the lever is a projecting piece G, at right angles with it; at the end of this is placed a small wheel with a flange H. When the lever E is in an upright position, the bottom of the wheel at its outer end is about an inch above the level of the rails on the main line, upon which the flanged wheels C are running. When it is

required that the truck shall be used on the cross line, the wheels H, of which there are of course four, are brought over the cross line, and the lever E being turned down and secured by a ball, the other wheels C, which are on the main line, are lifted up an inch from the rails, and the truck then proceeds along the cross line for its load upon the four smaller wheels now brought into action; on its return to the main line, they are raised again by the lever, and the other wheels descend upon the main line of rails, and the truck moves in a direction at right angles with the one it had just left. The dotted lines show the position of the wheels when moving on the cross line, and the full lines the position when working on the main line. The truck of course moves end foremost on the main line, and sideways on the cross line.

### PUMPS

should be provided for lifting and forcing both water and liquid manure, as it is essential that all the animals, and the different departments of the steading should be supplied with water, without the trouble of horsekeepers' and cattlemen having to fetch it from a distance.

A head of water should be placed in some convenient position in the steading, so that it may, by its own gravity, descend to all the various troughs, cisterns, and other receptacles.

The tank or head should be kept filled by a force-pump attached to the engine.

*Liquid Manure Pumps* are usually common lift-pumps of cast-iron (and often galvanised to prevent the rapid corrosion consequent upon their situation). Lift-pumps are employed because the tanks are only a few feet deep, and the pump is only employed to lift the liquid to the carts, and is worked by hand; but a different system of supplying liquid manure to the land is now coming into use, which

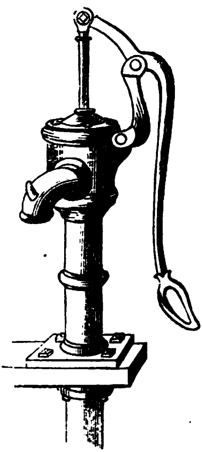
will require quite a different arrangement and kind of pump. The practice alluded to has been introduced by Mr. Huxtable, of Sutton Waldron, and is now also adopted by Mr. Mechi, at his farm at Tiptree Hall, Essex; it consists in laying down a regular main from the homestall to the lands and by a force-pump driving the liquid manure through it to the distant parts of the farm. Mr. Huxtable remarks that hitherto the expense of cartage has been an effectual impediment to the application of the contents of our tanks, except to a few fields around the homestead; and therefore there has been no systematic delivery of the precious fluid over all the farm. The method he first adopted was to lay down wooden pipes, carefully jointed; but experience afterwards showed that well burnt clay pipes, one inch thick and carefully jointed, would stand a pressure of 200 feet head, without the liquid oozing through the pipes or joints. The pipes were $1\frac{7}{8}$ inch in diameter, and cost *7d.* per yard; they are placed 2 feet underground, and at every 200 yards is inserted an upright column, bored to the same gauge as the pipes themselves; on the top of these is placed a spout for the delivery of the liquid. Mr. Huxtable's neighbours have some of them adopted the plan, and as Mr. Mechi has had an opportunity of ascertaining how it works, for some considerable period, and has now adopted it on his own farm, we may conclude that the plan having been fairly tried and found to answer well, will be generally adopted by the agriculturists of this country. If this is the case, fixed and larger engines will be employed on the steadings, as the labour of driving the liquid manure through the pipes to all the various parts of the farm should be done by steam-power; and a larger amount of other manures will be employed, as dissolved bones, guano liquid, or any other manure dissolved in water, may be forced through the main equally as well as the drainings from the cattle-stalls. In part I. p. 43, of this work, will be found a plan of a

horizontal steam-engine, and a force-pump alongside to be brought into use whenever necessary.

By an easy contrivance the pump may be made to draw from the receptacle of the liquid manure, and force it over the land: or the same pump may be made to draw from the well, and supply the cistern or head of water for the use of the farmery, as separate pipes would of course be prepared for liquid manure and water, and only the pump, barrel, and plunger work both; but these would in a few strokes quite clean themselves, and no inconvenience result from such an arrangement.

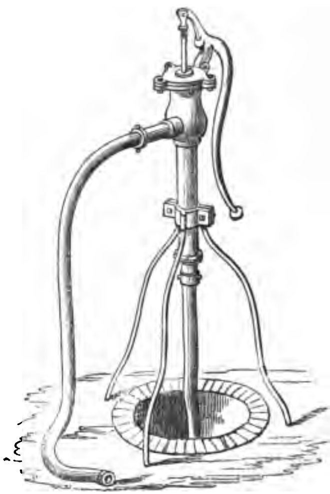
Steam power is so exceedingly economical when compared

Fig. 47.



LIFT-PUMP.

Fig. 48.



LIQUID MANURE-PUMP.

with the labour of either men or horses, that I apprehend the greatest possible benefit will arise from arrangements that throw the labour of either the one or the other upon

it; and the more this is done the larger power will the engine require to be; and the larger the engine the more economical will be its working, and, consequently, increased saving to the owner.

When a head of water is placed for the supply of the steading, an arrangement should be made to turn it to account in case of fire; and this may easily be done by having a coil of hose and a branch placed in some convenient situation, and cocks placed upon the pipes that supply the buildings. The situation of the cistern would of course not be placed higher than necessary, as it would entail useless labour in pumping; the force-pump, therefore, should be so arranged that it could be brought into use in the event of fire, and when worked by the steam engine would be so effective as to speedily get under any conflagration.

A steam-cock might be placed in the rick-yard, in such a situation as when a hose was attached any rick might be got at, should a fire be discovered in that portion of the premises.

END OF VOL. II.

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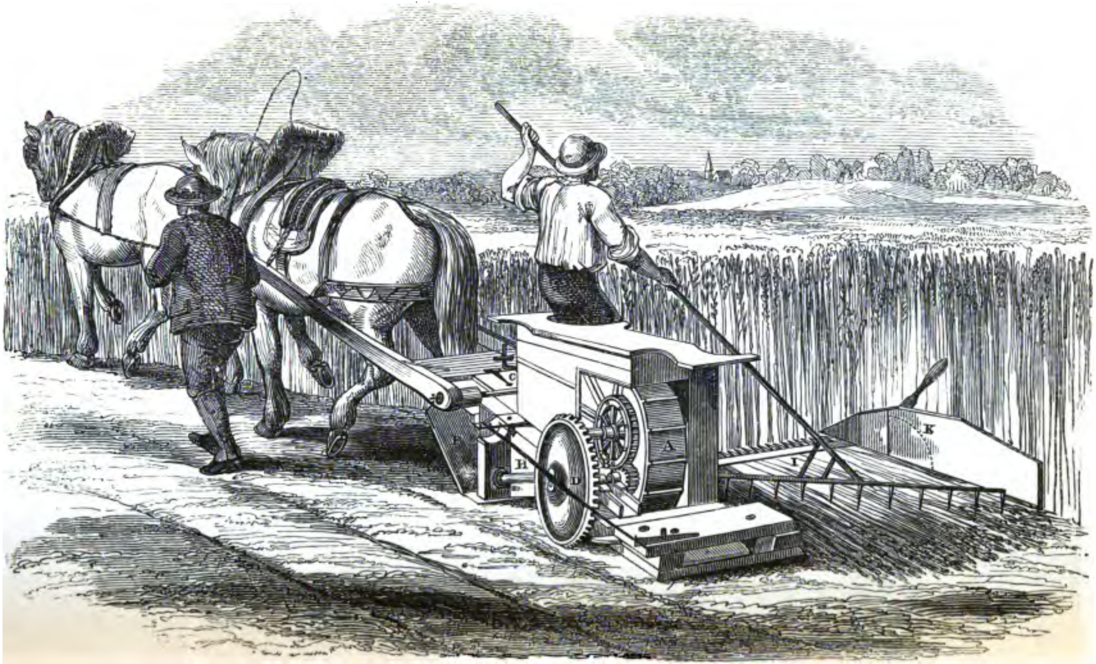


GARRETT'S REAPING MACHINE.

UPON HUSSEY'S PRINCIPLE.

RUDIMENTARY TREATISE

ON

# AGRICULTURAL ENGINEERING.

*With Illustrations.*

BY

G. H. ANDREWS, C.E.

VOL. III.

FIELD MACHINES AND IMPLEMENTS.

LONDON:
JOHN WEALE, 59, HIGH HOLBORN.
1853.

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TO

JOSEPH GIBBS, Esq. M.I.C.E.

THESE THREE LITTLE VOLUMES

Are Respectfully Dedicated

IN ACKNOWLEDGMENT OF THE MANY FAVOURS RECEIVED FROM HIM

BY HIS OBLIGED SERVANT,

THE AUTHOR.

# PREFACE.

This little Work on Agricultural Engineering was undertaken for the purpose of bringing, at a small cost, before the farmer such information as he would most likely need in reconstructing his farm-buildings, and in choosing his machinery and implements.

These objects the Author has endeavoured to carry out, and judging from the sale of the previous volumes, he flatters himself not unsuccessfully.

Although there are a variety of machines and implements that have been, and are occasionally used, of which no mention has been made; yet he believes that no machine or implement has been omitted that may be considered to be in ordinary use, and its efficiency and utility generally acknowledged.

In the case where a great number of different makers manufacture one kind of implement, of course it would be

impossible to mention more than one or two, who have by superior workmanship and greater attention to details, gained a reputation for it.

In conclusion, the Author begs to tender his sincere thanks to those gentlemen who have kindly supplied him with information upon the different subjects connected with the work, and more particularly to Mr. Garrett of Leiston, Mr. Howard of Bedford, Mr. Crosskill of Beverley, Mr. Hornsby, Jun., of Grantham, Mr. Haslem of Reading, and Mr. Woolnough of Leiston.

*The Elms Cottage, Brentford, Middlesex,*
*April*, 1853.

# CONTENTS.

## CHAPTER III.

## CHAPTER IV.



## CHAPTER V.



## CHAPTER VI.

# INTRODUCTION.

SINCE the time when these little volumes were commenced the great question that agitated the agricultural world, that is, whether corn should be for ever imported into this country free of duty has been finally settled. Free-trade is now the law of the land, and the British farmer has to compete with the corn-growers in all the countries of the world, some of whom have been especially favoured by Providence, in the situation of their land, their climate, and the natural fertility of their soil. Freight only is in favour of the home-grower, and this is now reduced so low as to be an exceedingly small matter in the question; a hundred miles of ocean may be traversed as cheaply as one mile on the turnpike-road, and a farmer, whose market is a dozen miles from his homestead, is not much more favourably situated than he who grows corn on the banks of an American river.

Farmers, we all know, have not been getting the monstrous profits their opponents would pretend; in fact, the tenant-farmer has not, for many years, been in a position to make more than a very moderate per centage on the capital he has embarked in agricultural operations, and a small remuneration for his own labour.

It becomes a matter of no small importance, then, that he should consider now in what direction he must look for means to compensate him for the privilege he has hitherto

enjoyed, that he may compete successfully with his more favoured rivals. An improved system of agriculture I conceive to be the principal point towards which attention should be directed; if he can at the same time get his landlord to lower his rent, so much the better; but the lowering rents will not give anything like the advantage to be gained by an improved system of cultivation, to be carried out by reconstructing all the buildings on a proper plan, giving the maximum accommodation for the minimum cost, economising labour and promoting the welfare of the stock, draining the whole of his lands in a perfect manner, employing all the most recently-invented machines for diminishing the cost of working his land, and, lastly, though by no means least, farming only just so much land as he has capital to work to the highest pitch of which it is capable. I believe if this be done under a good landlord, where the rent is equitably adjusted, the cultivation of the soil and the production of human food, may still be a profitable occupation.

The great difficulty the agriculturist labours under is, to know what plan to adopt when so many are offered; he hears of wonderful discoveries being made which are entirely to supersede old and established plans, new methods, new manures, new courses, and new crops, and before he has time to make a trial, he finds they are abandoned: they did not answer. First, he is told to sow an abundance of seed, then that everything depends on not sowing one grain more than is required for a plant; or he is told he cannot have his tiles laid too deep, and an equally eminent authority informs him that shallow drainage is much the best. The poor farmer gets bewildered with the thousand and one schemes put before him for his advantage, and consequently continues to go on in the old way, preferring that to the plans of those persons who only benefit the science of agriculture by publishing the history of their errors.

Next to the introduction of artificial manures (which has enabled a large amount of land to be covered with heavy root crops, that could not else have been so used), the great advances made of late years in the construction of agricultural machinery and implements has been of the first importance; all the operations necessary to produce a fine tilth, to clean the land from weeds, and to facilitate the operation of housing, being now effected in a much superior manner, and at half the time and cost formerly required. It is in this direction particularly that the agriculturist should seek for greater assistance.

First, it is of importance that a steam-engine, or other motive power, be adapted to do all the heavy work of the farm, and all the duties that possibly can, be thrown on the back of this cheap, never-tiring, and constant helper. The first outlay for engine and boiler of six horses power will not be more than the cost of six horses, and the price of fuel is now reduced to an exceedingly low limit, Messrs. Hornsby having been some time working at 5lb. of coal per horse-power per hour, and latterly have considerably diminished that; and when Mr. McConnell's improvements are applied, I have no doubt but that a still further reduction will take place; an immense saving will of course be made on farms of any magnitude by the introduction of steam machinery.

A system of agricultural railways, also, would be of importance to the farm; and that all farms will, in a few years, have a railway laid from the homestead through the lands, I have not the least doubt, as the carrying so heavy an article as manure on to the field is one of the most costly duties on the farm. The same railway would also facilitate the bringing back the produce of the fields to the homesteads, and afford means for getting the business of the farm concentrated at the steading.

Now, if the gauge of the farm-railway be the same (4 feet 8½ inches) as the great lines of the kingdom, why should not

branch lines be constructed from the railway to the farms along the side of the roads? or on any other convenient plan? so that the farmer might be able to get a truck from the head of his field on to the main line of railway, and thus convey it to a near, or most distant market, without the trouble and expense of frequent shifting.

I do not consider the railway system of this country half developed until there are railways instead of parish roads, instead of green lanes, and instead of the road at the field's-head.

Of course it is not to be supposed that these railways are all to be constructed in the same substantial manner in which the great trunk-lines are made, the cost must diminish from the passenger line progressively with its traffic and importance, until it is laid down the middle of the field as by Mr. Croskill at 3*s*. 6*d*. per yard.

# CHAPTER I.

## MACHINERY AND IMPLEMENTS FOR DRAINAGE.

PREVIOUS to any operations being commenced for cultivating land, it is necessary to thoroughly free it from water. Land is injuriously affected by water in several different ways, and different machines and implements are used under different circumstances.

1st. In the case where land is situate so low as to be permanently or occasionally flooded, by freshes from rivers running through it, high tides, or other such circumstances.

2ndly. From the nature of the subsoil being so impermeable as not to allow the water that has fallen from the clouds to descend through it, consequently the land, or cultivated soil, remains for a long time in a saturated and overcharged state, utterly unfit for growing plants.

3rdly. From water rising upwards through the soil as springs, caused by the pressure or height of the water in some other place; and 4thly. Where the upper surface of the soil is beaten by the action of the rain into a puddled covering, in which all the interstices are stopped up, and consequently no air can get down to the plants.

In the cases of land being subjected to be flooded by the sea or rivers, the operations are on a much larger scale than the others, and should always be executed by the Civil Engineer. Many works of this description have been executed in England, and the whole country of Holland is protected from such inroads by an immense number of

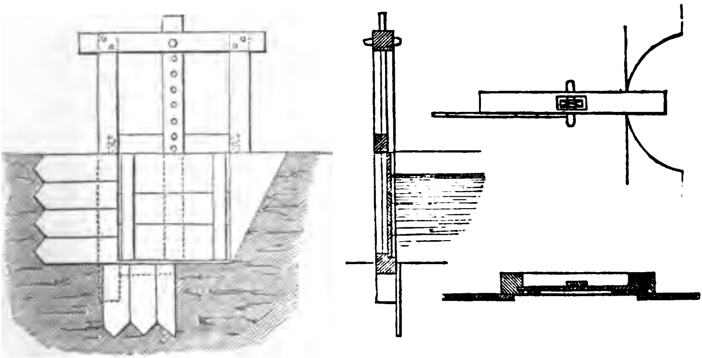
most admirable and scientific works. In England the district called the Fens is situated in the manner alluded to, and the whole owes its cultivated existence to the efficiency of the great drainage works there executed, the foremost of which is the Great Bedford Level. The works usually constructed in these cases are, First, an arrangement of earth-banks for keeping the waters into their proper channels; secondly, sluices and gates for allowing the waters contained within the banks to run out to the lowest level that can be obtained; and, thirdly, engines and machines for lifting out the water that remains, and that is lower than the natural outfall, into higher channels. Sluices (or hatches, as they are generally called in England), are gates for regulating the flow of water; when of small dimensions, they usually consist of two upright pieces of timber, the lower ends of which are tenoned into a sill, and the upper end secured in the same way into a flat piece of timber.

On the inside face of the two upright pieces are cut grooves perfectly true. In this groove, a gate made of a series of boards, of the width between the grooves, and fastened to an upright piece of timber, as shown in fig. 1. This gate slides up and down in the grooves as required. The centre upright has a number of holes bored through it, and the cross-piece or cap, one. When the gate has been lifted up to the necessary height, an iron pin is passed through the hole in the stem of the gate, and into the corresponding one in the cap; it is thus held in any position that may be thought necessary.

When these works are large and the gates become heavy, it is necessary to contrive some means of lifting them, as it could be no longer done by merely hoisting them with the hand. A rack is then placed upon the stem, and a pinion properly fixed upon the cap, the teeth of which gear with those which form the rack, a winch is applied, and the gate is raised or lowered with great facility.

When a very large quantity of water has to be dealt with, a series of gates are placed in a row; they are constructed in

Fig. 1.

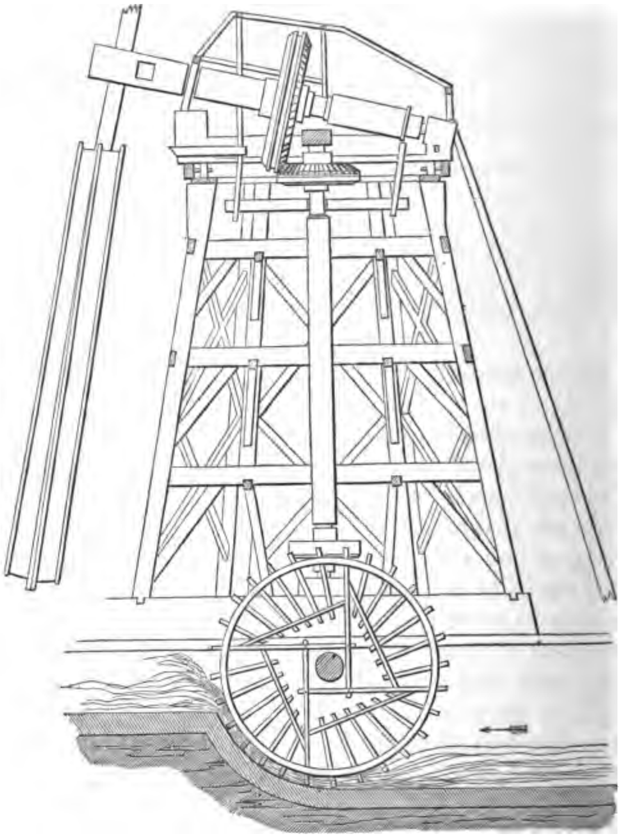


a manner precisely the same, only the framing has to be braced and secured in a stronger manner.

A series of small hand-gates, called shuttles or flashes, are sometimes placed on the top of the larger gates. The principal conditions to be observed in the construction of these works are, that they shall be an effectual guarantee against floods, or any sudden rise of the water in the channels. They should be as permanently constructed as possible, and be made to work easily, which they very seldom do, and a great deal of hammering and heaving with crowbars takes place when they are required to be opened; this is more especially the case when the gates are made too wide, which they often are; great care should also be taken in making a sound junction with the banks and the wings of the sluice-frames above, so that no water may find its way through from the back. As much water as will, having flowed through the sluices, the next operation is to lift the remainder up to that level, that it also may be got rid of. A great variety of machines have been used for this purpose in ancient and

modern times, but those now generally in use are either the Dutch Scoop Wheel or the Cornish Pumping Engine. Throughout Holland scoop-wheels may be seen in constant

Fig. 2.



SECTION OF DUTCH DRAINING WINDMILL AND SCOOP-WHEEL.

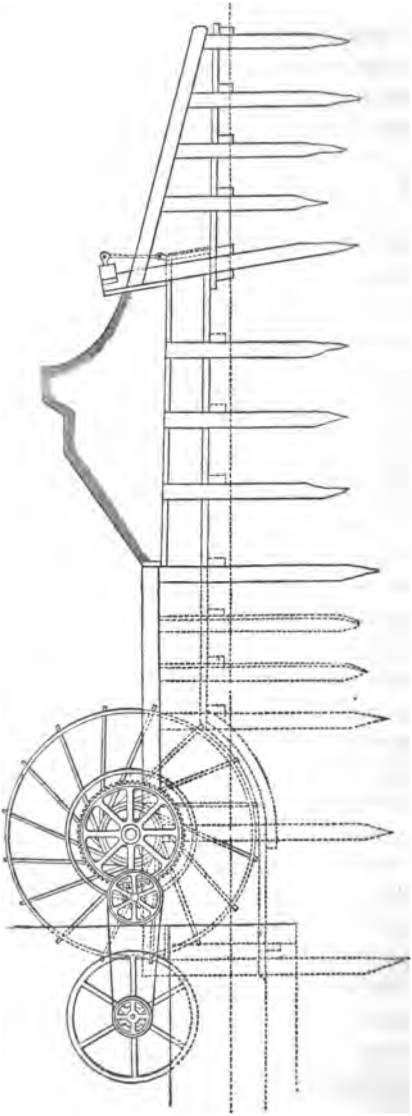
use, draining the polders. They are chiefly driven by windmills. Fig. 2 is a section of one of these draining machines,

showing the manner of driving the wheel. The mill is constructed similar to an ordinary flour-mill, but the upright shaft is carried down to the bottom floor, where a bevel wheel is placed upon it, and another on the shaft of the scoop-wheel, to which it communicates the motion. The scoop-wheel, or flash-wheel, as it is often called, is constructed of a series of flat blades, radiating, but not from the centre of a shaft similar to ordinary water-wheels, the blades work in a chase which they accurately fit, and in their revolutions force the water before them from the lower to the higher level, as shown in the annexed section.

These machines are not economical or effective in lifting the water above the centre of the axle,.the loss of water between the circumference of the blades and the race increases when the speed of revolution diminishes, but this loss may be reduced to the lowest point by making the blades rectangular, and of a width equal to double their height. In the fen districts of Lincolnshire, Mr. Glynn has erected some powerful machinery of this nature. One of these, erected on the Ten-mile Bank, near Little Port, in the Isle of Ely, is driven by an 80 horse-power engine, with a wheel 40 feet diameter. The Deeping Fen, near Spalding, with an area of 25,000 acres, is drained by two engines of 80 and 60 horse-power. The 80 horse-power engine works a wheel of 28 feet diameter, with float-boards 5½ feet by 5 feet, and moving with a velocity of 6 feet per second on the average, when the engine has its full dip; and consequently the sectional area of the blades lifting the water is 27½ feet. The quantity discharged per second is 165 cubic feet, or about 4½ tons, raised 5 feet in height.

On the bank of the Old Bedford river, which empties into the Ouse at Salter's Lode Sluice, is the Manea and Walnea District Engine. It is of 60 horse-power; the diameter of the flash-wheel 32 feet, width of floats, or lodes, 2 feet 9 inches, making 3½ revolutions in a minute. It drains

Fig. 3.



SECTION OF BANK AND SCOOP-WHEEL AT LOCH FOYLE.

8685 acres, the cost of coals being *7d.* per acre. The Sutton and Mepal Engine is built a little higher up on the same bank, and throws its water into a canal called the Counter Drain, which empties itself into the Bedford river. It is 80 horse-power; the diameter of the wheel being 32 feet, and the width of the lodes 4 feet, making 3½ revolutions per minute. It drains about 10,348 acres, at a cost of 7½*d.* per acre for fuel, &c. The District Drainage Tax is from 4*s.* to 6*s.* per acre.

Fig. 3 represents a section of the bank, and the arrangements for driving the scoop-wheel, erected at Loch Foyle, by Joseph Gibbs, Esq. The wheel in this case was constructed of wrought iron, and was 18 feet in diameter.

The engines are usually provided with three boilers; a 40 horse engine has three boilers of 30 horse-power each, two being used while one is being cleansed or repaired. It is proved by practice that two boilers of 30 horse-power will generate steam for a 40 horse-power engine, much more economically than one 40 horse-power boiler, caused chiefly by the furnace not being required to be so often disturbed in the one case as the other. The cost of a steam engine, including the building and fixing, for purposes of drainage, is about 100*l.* per horse-power.

The engines we have hitherto described are all employed in lifting water, by giving motion to a scoop-wheel, but in many cases steam engines have been erected for the purpose of lifting water by means of pumps. Of these there are a great variety. We can have only space here to glance at the most remarkable that have been invented for the purpose, and that have been found in practice to answer. By far the largest and most justly celebrated of these are the engines erected for the drainage of the Great Lake of Haarlem in Holland.

As I have before observed, the low lying lands of Holland are all drained by the use of scoop-wheels, worked by water

power. These mills are the pride of the Dutch engineers, and certainly they are very fine machines and exceedingly effective, and until it was proposed to drain the Haarlem lake, were considered to be a far superior method to any other in use; but two English engineers, Joseph Gibbs and Arthur Deane, both having had considerable experience in the Cornish engine, seeing that such a machine would be far better adapted for the purpose, undertook the very difficult task of proving that fact to the Dutch commission of engineers who had been appointed to report upon the best method of draining the lake; and after a long and tedious inquiry, slow even for Dutchmen, they at length came to the determination to adopt the plans of the English engineers, and one scarcely knows which feat deserves the most credit, the persuading the Dutchman to give up his wind-mill and scoop-wheel, or the actually getting the water out of the lake (as by this time it is).

Messrs. Gibbs and Deane's plan was to construct three large engines on the Cornish principle, but of peculiar design, particularly suited to the character of this work.

The area of the lake of Haarlem is equal to 45,230 acres, and its average depth about fourteen feet, the cubic contents of the whole being equal to about 800 millions of tons of water.

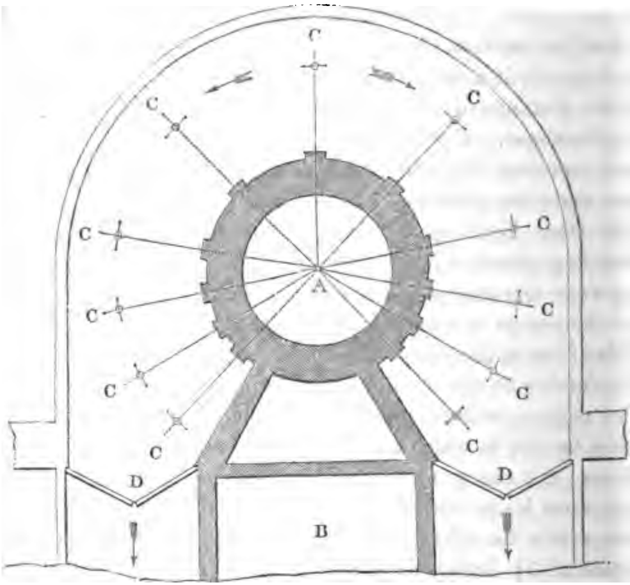
The longest side of the lake is parallel with the sea, and separated from it only by a narrow strip of land; the three engines were placed at different parts, so as to have suitable outfalls. They are severally called the Leeghwater, the Croquis, and the Van Lynden; these names given to the engines were those of three celebrated engineers who had at various times interested themselves in the drainage of this great lake.

Of these three engines the "Leeghwater" was first erected, with suitable houses and pumping machinery. The first step in this work was to construct an earthen dam of a

semicircular form, enclosing about 1½ acre of the area of the lake, and adjoining its bank. The space inclosed by this dam was then cleared of water by a small steam-engine, and the foundations for the houses and machinery commenced. These foundations consist of 1400 piles, which were driven to the depth of 40 feet, into a stratum of hard sand. Upon these piles, and at the depth of 21 feet below the surface of the lake, a strong platform was laid, and upon this a wall, pierced with arches, was constructed, at the distance of 22 feet from the intended position of the engine-house. Upon this wall a thick flooring of oak was laid, between the wall and the engine-house. The pumps rest upon the platform, beneath and opposite to the arches, and their heads pass through the floor just described, standing about 3 feet above its level. Into the space left between the engine-house and outer wall, the water raised by the pumps is received, and discharged from it on either side of the boiler-house, through sluice gates, into the canals conducting to the sea sluices. The general arrangement of the engine, boilers, pumps, and sluices will be understood from fig. 30, in which A represents the engine; B the boiler-house; C C the pumps; and D D the sluices through which the water is discharged. The engine has two steam cylinders, one within the other, united at the bottom, but with a clear space of 1½ inches between them at the top under the cover, which is common to them both. The large cylinder has an annular piston, both pistons are connected by one main piston-rod (of the internal cylinder) 12 inches diameter, and four small rods (of the annular piston) 4½ inches diameter each, with a great cap or cross head, having a circular body 9 feet 6 inches in diameter, and formed to receive the ends of the balance beams of the pumps. The pumps are eleven in number, and each of them 63 inches in diameter, with a cast iron balance beam turning upon a centre in the wall of the engine-house, one end of which is

connected with the great cap of the engine, the other to the pump rod. Each pump rod is of wrought iron, 3 inches in diameter, and 16 feet long, with an additional length of 14 feet of patent chain cable attached to the pump piston.

Fig. 4.




PLAN.

The steam and pump pistons have a stroke of 10 feet in length; each pump is calculated to deliver 6·02 tons of water per stroke, or 68·22 tons for the eleven pumps. The quantity actually raised is found to be about 63 tons. The action of the engine is as follows:—The steam being admitted, the piston and great cap are thereby raised, and the pump pistons make their down-stroke. At the top of the steam-stroke a pause of one or two seconds is made, to

enable the valves of the pump piston to fall out, so that, on the down-stroke of the steam piston, they may take their load of water without shock. In order to sustain the great cap and its dead weight during this interval, an hydraulic apparatus is brought into use, which consists of vertical cylinders, into which water is admitted, forcing upwards two plunger holes which sustain the cap, the water being prevented from returning by spherical valves fitted at the lower parts of the cylinders. The arrangement of the two steam cylinders is adapted in order to bring the load under immediate command, the varying character of which would otherwise require occasional alteration of the dead weight to overcome it, which would involve great delays and inconvenience. By the use of the two cylinders, the dead weight raised by the small piston does not usually exceed 85 tons, the extra power required being derived from the pressure of the return steam at the down-stroke upon the annular piston. A skilful regulation of the expansion and pressure of steam in the small cylinder thus enables the engine-man to provide for all cases of difference of resistance without the delay of altering the dead weight. Respecting the power of the "Leeghwater," it appeared from experiments conducted by a sub-committee of the commission, that the duty was equal to that of raising 75 million lb. one foot high by the consumption of 94 lb. of good Welsh coal, and exerting a net effective force of 350 horse-power. The lift being 13 feet, the engine works the eleven pumps simultaneously, the net weight of water lifted being 81·7 tons, and the discharge 63 tons per stroke. When the site of the lake is cultivated, the surface of the water in the drains will be kept at 18 inches below the general level of the bed, but during floods the waters of the upper level of the country will be raised above their usual height, and the lift will be increased to 17 feet. To test the power of the engine to meet these cases, the eleven pumps were worked simultaneously without

regard to economy of fuel, and 109 tons net of water were raised per stroke to the height of 10 feet. The boilers of the "Leeghwater" engine are five in number, cylindrical, and each 30 feet long, and 6 feet in diameter, with a central fire tube 4 feet in diameter. Under the boilers a return flue passes to the front and then divides along the sides. Over the boilers, and communicating with all of them, is a steam chamber 42 feet in length, and 4 feet 6 inches in diameter, from which a steam pipe 2 feet in diameter, conveys the steam to the engine. The consumption of fuel is 2½ lb. of coals per horse-power per hour, with working with a net effect equal to the power of 350 horses. The cost of the "Leeghwater" and machinery was 21,000*l*. It has been calculated that the entire cost o. the works for draining the lake will be 100,000*l*. less than would have been incurred by adopting the ordinary system of steam-engines and hydraulic machinery, and 170,000*l*. less than the expense of applying the system of windmills hitherto prevailing in Dutch drainage. The annual cost of the three methods is thus estimated:—By three engines such as the "Leeghwater," 4500*l*.; by windmills, 6100*l*.; and by ordinary steam engines, 10,000*l*. Besides the ordinary plans of pumps attached to Cornish engines, there have of late been introduced a great variety of pumps, among the most remarkable of which are Appold's and Gwinne's pumps.

Mr. Appold's constituted one of the principal attractions in the department of machinery in motion at the Great Exhibition of 1851, and might be seen constantly delivering, at a considerable elevation, a powerful stream of water, which was not a little refreshing during the hottest portion of weather. Mr. Appold's pump is similar in every respect to the mill known as Whitelaw's mill, but the action is reversed: in the former, a column of water descending by pressure on the horizontal wheel, causes it to revolve, and

it is then used as a motive power; but in the latter case, some other motive power is used to cause the horizontal wheel to revolve, and lift the water, it thus becomes a pump of considerable power. Mr. Appold's wheel was only 12 inches in diameter; it received the water on each side, through apertures of 6 inches diameter, and had a central disc or diaphragm perpendicular to the axis, intersecting the vanes, forming, as it were, a double wheel, revolving between two cheeks, that projected from opposite sides of the reservoir.

The curvature of the vanes was found to be a matter ot considerable importance, as it would discharge, when so constructed, more than double the quantity of water in the same time, and with the same power, as one constructed with straight vanes.

A trial was made with Mr. Appold's pump against two others of the same size, the one with straight vanes, inclined at an angle of 45 degrees, and the other with radial arms—the following results were obtained:—

| | REVOLUTIONS PER MINUTE. | GALLONS RAISED PER MINUTE. | HEIGHTH RAISED. | USEFUL EFFECT. |
|---|---|---|---|---|
| MR. APPOLD'S WHEEL | 792 | 1664 | 18 feet 8 in. | ·649 |
| „ „ . | 788 | 1236 | 19 „ 4 „ | ·680 |
| INCLINED VANES . | 694 | 560 | 18 „ 0 „ | ·394 |
| „ „ . . | 690 | 736 | 18 „ 0 „ | ·434 |
| RADIAL VANES . | 624 | 369 | 18 „ 0 „ | ·232 |
| „ „ . . | 720 | 474 | 18 „ 9 „ | ·243 |

## THOROUGH DRAINING.

The water at the outfall having been lowered either by deepening the channels or lifting the water by some of the means we have described, another department of draining is commenced, called thorough draining. This consists in laying across the land at intervals, and at a few feet below

the surface, lines of tiles constructed of such shapes as that, when they are laid end to end, they form a continuous pipe, and being made of porous material the water passes through them, and in at the joints, then finding a ready course through to the main drains. These pipes are made of a variety of shapes, sometimes forming a perfect pipe in one piece; and at others they are composed of two pieces, the upper one shaped like a horse-shoe and laid upon a flat piece called a sole. These are very rarely used now, a circular pipe being found to be the best form and the most easily constructed.

The tiles with soles were the first used, and, as no machinery then existed for constructing them, doubtless that form was best as it was easily made, being two flat pieces made like plain tiles first, and then one piece was bent over a saddle-shaped block of wood, and after being dried was burnt in that shape, and when laid in the ground formed an excellent drain; but as machinery came into use other forms were adopted, and the sole or bottom of the tile became a part of it.

A variety of ingenious machines have at various times been patented for constructing drain tiles, and although many of them exhibit great mechanical ingenuity and are very interesting, we cannot afford space in this little book to describe more than one or two that have come into general use: of these the most known are the Tweedale machines, Beart's, Ainslie's, Hart's, and Clayton's.

The last-mentioned machine I can recommend as one of the most efficient and generally useful of them all. I know many persons who use them, and generally they give satisfaction. They are made entirely of iron, and adapted to manufacture tiles either vertically or horizontal; which is an important advantage, as in the manufacture of large pipes they never keep their shapes when passing over horizontal rollers, consequently they have a flat side, and

from being so misshapen will not fit properly when laid end to end.

Most tile machines act upon the principle of forcing the clay through discs, in which are openings cut to the shape of the tile, as seen in cross section. The various ways in which this simple operation is performed, constituting their peculiarity, Clayton's is simple, strong, and compact, and equally well suited for all kinds of work.

The clay is contained in two large cylinders attached to the frame by swing brackets, so that no delay takes place by filling, one cylinder being replenished while the other is being discharged. The internal shaft-work is formed of wrought iron; the clay is forced out of the cylinder through the perforations in the discs by a piston, which is acted upon by gearing so arranged that it takes twenty-five turns of the winch to force the piston down and only four to lift it up again. The cylinders are fitted with perforated metal plates or gratings, of various sizes, for screening the clay from all stones, roots, or other extraneous matter that would be injurious to the formation of the tiles. Two men and a boy will make with this machine, if the clay be in the best order, about 10,000 feet of pipe per day, working piecework.

A great variety of machines on a similar principle to Clayton's are manufactured by various persons, all constructing the tiles by forcing clay through discs: in some the cylinders are horizontal, and in others vertical.

A great impetus was given to the manufacture of drain tiles by machinery by the invention of a tile-making machine by Mr. Beart, of Godmanchester, Huntingdonshire. This gentleman, a very ingenious and excellent mechanic, constructed a tile-works on a large scale, and conducted all his operations in a very superior and methodical manner. The consequence was an immense saving in cost of manufacture. A statement by Mr. Beart of his machine and the system pursued will be found in the "Journal of the Royal

Agricultural Society," vol. ii. part 1. A saving of 2*s*. 6*d*. per thousand was at once made by the introduction of the machine, and a greater facility given for the execution of a larger amount of work with greater regularity. This machine was not for making pipe tiles, but intended to facilitate the making of horse-shoe tiles, which are formed of one piece bent as before described over a piece of wood called a horse.

## MACHINES AND TOOLS FOR LAYING TILES.

Only one machine is in use at the present time for effecting this object. This is the one known as Fowler's draining machine, and is the invention of John Fowler, jun., of Bristol, who received a silver medal from the Royal Agricultural Society of England, at the meeting at Exeter in 1850, for his invention. It was described by the inventor as a mole or plug plough for making a hole in the soil at depths varying from two to four feet, and at the same time drawing into the hole thus made any draining material, such as earthen or wooden pipes, straw, ropes, &c.

There is an apparatus attached for raising or sinking the plough, so as to lay a level drain under an uneven surface: it is drawn by the power of a windlass, and one horse's power exerted there will move the plough a yard in twenty seconds at a depth of 2 feet 6 inches. Three horses, four men, and six boys will keep two ploughs going, and do 4000 feet in a day at a depth of 3 feet.

A hole requires to be dug for the machine at every hundred yards, or six for an acre.

This implement, as might be expected, was an object of much attention at the meeting, and various were the speculations of visitors and the judges as to the difficulty it would experience in laying tiles in stony and gravelly soils. The machine was again exhibited at the Great Exhibition in

Hyde Park in 1851, having been considerably modified and strengthened. Public trials were also made with it on Wormwood Scrubs.

I am not aware of its being in use anywhere at the present time, nor do I think it in its present state at all adapted for laying tiles on the generality of soils. There are situations, doubtless, as bogs, where a machine of this character might be used with advantage; but wherever it is the soil must be free from stones, either in beds or as boulders, the upper surface of the land very even, and the tiles of first-rate quality. The principle upon which the machine acts is very simple. The reader will imagine a deep knife fixed under the beam of a wheel-plough; at the bottom of this knife a pointed piece of iron fixed horizontally; at the back of this piece of pointed iron is attached a chain or rope, and upon this rope are threadled, one after another, lengths of the pipes or tiles to be laid; a strong windlass attached to horse-gear is placed at a distance in front of the plough, and a chain from the barrel of the windlass is attached to the end of the plough-beam. A hole is then dug to allow the deep knife and pointed iron to enter the ground at the intended depth; the plough is then drawn forward, the knife cutting the earth through and the iron point making a passage for the string of tiles to follow. When the plough has arrived at the windlass the rope is hauled out, and the tiles of course remain properly laid, end to end, and with greater accuracy than could be done by the ordinary means. To ascertain the state in which the tiles are left by the machine, a trench has been afterwards cut and the tiles examined, and invariably they have been found to be very properly laid.

It appears, therefore, that as far as the actually laying tiles at moderate depths in certain soils, this machine answers the purpose intended; but there are so many circumstances that would interfere in different localities,

as to render it very doubtful whether it can become a machine of general application.

## GIBBS'S DRAINING MACHINE.

Some few years since a machine was placed in my hands by Mr. Josh. Gibbs, an eminent civil engineer, which he had himself invented and constructed, for the purpose of laying tiles without the necessity of opening the ground to a greater width than the chase in which the tile itself had to be laid. I tried a variety of experiments, and it gave the greatest possible satisfaction. An experienced drain-tile layer, who assisted in them, assured me he could lay tiles as well with its assistance as when the ground was opened wide enough for him to stand on the bottom of the opening.

Of course it could not be expected that this, the first attempt at the construction of such a machine, should be perfect, and answer equally well in all situations; but of this I am certain, that had the inventor followed up the subject a little further, a very great benefit would have been confered on agriculture generally by giving much greater facility for the laying deep drains; and I am still in hopes, when less pressed with other business, he will make perfect this admirable machine.

## DRAINER'S TOOLS.

The ordinary manner in which the drain-tiles are laid is by cutting an opening in the ground, gradually narrowing in towards the bottom so as to require as little soil as possible to be removed. To effect this in the best manner, the tools or spades must be made in sets, the smallest being no wider than the tile to be laid.

These are made by most implement-makers of the most approved forms to suit the different depths. Mr. Clayton, of

the Atlas Works, Dorset Square, whose tile-making machine we have before alluded to, manufactures very superior tools for cutting the gripes in different soils, either clay or gravel. These tools are made with ground-polished blades, and upon scientific principles as to shape; they are formed with cycloidal blades, which gives strength and lightness, and produces the best form of cutting-edge, as well as allowing the clay to leave the tool more easily than is the case with those made in the ordinary manner. Besides the tools for excavating, one or two others are necessary for cleaning out the bottom and laying the tiles; but however well the tiles may be laid, the work is inefficiently done if the drains have not been properly set out and the levels accurately laid.

## CHAPTER II.

### THE PLOUGH.

The plough is the most important and valuable implement, and the one most generally used in agricultural operations; being the fundamental implement, it is common to all ages and countries. Mention of it is made in the earliest writings upon agriculture; indeed, its introduction must have been coëval with the first attempts at cultivating land and raising corn. The tillage of land is supposed to have been first practised in imitation of the effects produced from deposits of sand and mud by retiring rivers after floods and inundations. These effects must have been observed by the inhabitants, as herbage springs up spontaneously, as soon as it is left dry, and subjected to the heat of the sun's rays.

The peculiar characteristics of certain portions of Egypt would favour the hypothesis that corn was first cultivated in that land, as it is spoken of in the earliest times as so

fruitful in grain as to be considered the granary of the adjacent countries.

Sir Isaac Newton and Stillingfleet both considered that corn was first cultivated on the banks of the Nile in Upper Egypt, where the waters only occasionally covered the land, leaving it ample time to profit by the deposits of mud and sand, and put forth the plants peculiar to it. The inhabitants, observing this hint from nature, that nothing more was necessary than to scatter the seed in this soil, and that it would then vegetate and bring forth fruit in abundance, endeavoured to imitate it by cleaning the ground of weeds, and mixing the rich sedimentary deposit of the river with pure sand.

To effect this at all, an implement of some kind must have been used, and that was the first plough. Antiquaries have agreed that this must have been a sort of pick, and little else than the merest scratching of the soil would be necessary under such circumstances as they were placed in. Various representations are in existence of very early ploughs of this kind.

As other lands gradually became cultivated, an improved form of plough would doubtless be constructed to meet the requirements of local circumstances, as agriculture was carried to a great pitch of perfection in Egypt. Of this the numerous traces remaining to this day bear ample testimony, such as the banks and canals in lower Egypt, especially in the Delta, traces of no less than eighty canals exist for the purposes of draining and irrigating. We find the plough (1 Sam. xiii. 20) had a share and coulter, indicating a considerable advance in the construction of an efficient implement. From Egypt the art of cultivating the soil found its way into Greece, the aboriginal Pelasgi being civilised by colonies from that country. The little that is known of the practice of the Greeks is obtained from the works of Hesiod, called "Works and Days." He was contemporary with Homer, and culti-

vated a farm at Askra, at the foot of Mount Helicon in Bœotia, and grumbles like any modern farmer at the badness of his land, which, he says, is too hard in summer and too soft in winter, and never very good at any time. I should fancy his occupation was a piece of good rank stiff clay, as little loved at the present time as in the days when he wrote. He describes the ploughs of his time as being composed of three principal parts: the share-beam (which is to be made of oak), the draught-pole, and the plough-tail (to be made of elm or bay), and the whole to be securely fastened with nails and pegs; he also recommends that a spare plough be kept ready to be used in case of accidents.

*Roman Ploughs.*—Of these a great variety must have been in use, as they are mentioned by various Roman writers on agriculture, as having peculiar characteristics adapted to the particular soil or description of work to be done. Mr. Adam Dickson, in his work on the husbandry of the ancients, says, "It is probable that I shall be considered as very partial to the ancients, if I do not allow the moderns to excel them in the construction of their ploughs. We are not indeed so well acquainted with the ancient ploughs as to be able to make a just comparison. I shall only observe, that from the few passages in the rustic authors concerning them, it appears that the ancients had all the different kinds of ploughs that we have now in Europe, though not perhaps so exactly constructed. They had ploughs without mould-boards, and ploughs with mould-boards; they had ploughs with coulters, and ploughs without coulters; they had ploughs without wheels, and ploughs with wheels; they had broad-pointed shares, and narrow-pointed shares; they even had what I have not yet met amongst the moderns, shares not only with sharp sides and points, but also with high-raised cutting tops. Were we well acquainted with the construction of all these, perhaps it would be found that the improvements made by the moderns in this article are not

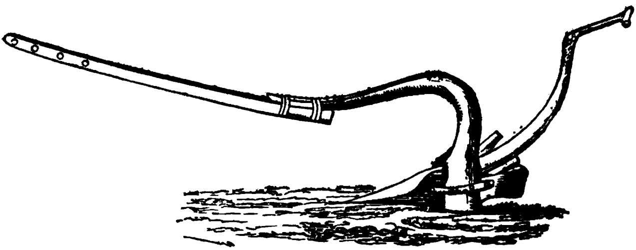
so great as many persons are apt to imagine."[1] Without quite following Mr. Dickson to the full extent of his admiration of ancient implements of tillage, we must admit that very considerable perfection had been attained in the construction of the plough, judging by the numerous descriptions found in the works of the different authors. Cato mentions two ploughs, one called the Romanicum, proper for stiff land; and the Campanicum, as adapted for a light soil. Varro mentions a plough which must have been similar to an ordinary modern ridge-plough; it was used for ploughing in seeds, and was fitted with two mould-boards. Pliny speaks of fitting a piece of board to an ordinary plough, in order to adapt it to the purpose of ploughing in seed. Palladius speaks of a plough for ribbing up land when the water lays much in the furrow, in wet seasons.

Ploughs answering to the descriptions of the classic authors may now be found in different parts of Italy and Sicily; and in various parts of Europe and Asia are ploughs still in use of the most primitive forms, and very much inferior to what I imagine the ancient Roman ploughs to have been, judging by the descriptions handed down to us. The Araire of the South of France is an implement of this rude kind, merely dividing the soil, and pushing it in front of it. The plough of Asterobothnia, in Scandinavia, is often drawn by one man, and is little more than one of the ancient scratching-tools first used in Egypt, and represented upon the images of Osiris. The plough of the Morea of Greece is similar to the fluke of an anchor, and is drawn by two asses or one horse. The Syrian, the Persian, and the Indian and Chinese ploughs are all of the same character, being merely scratching implements, and scarcely deserving the name of ploughs.

The annexed cut represents the modern plough of Castile. It is engraved from the original sketch kindly lent me for this purpose by my friend, Mr. J. Telbin, and was drawn from nature by him, while making sketches in Spain for his

Panorama of the Campaigns of the Duke of Wellington. I have preferred giving a cut of this plough to any other, as I could rely on its accuracy, and it is interesting, as showing the extremely low state of agriculture in Spain at the present

Fig. 5.



moment, it being impossible that any efficient system of husbandry can be carried out where such a rude implement as this forms the principal feature; and it is not only in the plough that the modern Spaniard is so far behind, even the ancient Roman farmer, much more the modern scientific agriculturist, for Mr. Telbin described to me the manner of thrashing, as he saw it practised in Spain in 1850, and which is not one bit in advance of the old custom of treading out the corn by the feet of oxen. The plough was first introduced into Britain by the Romans, and there are many rude drawings in existence, representing different kinds of ploughs. Some of these are very similar to the Castilian specimen shown in the cut, while others, used by the Saxons, are shown as having wheels, and in several cases the horses are represented as fastened to the plough by their tails, a barbarous custom that existed in Ireland as late as 1634, for an act of the Irish Parliament, 11 & 12 Car. II., c. 15, entitled an "Act against plowing by the tayle and pulling wool off living sheep," sets forth, that "Whereas there have been for a long time practised in this country a barbarous custome of plowing, harrowing, drawing, and working with horses

and other animals by the tayle, whereby the breed of animals in the kingdom is much impaired, and great cruelty perpetrated, these practices were henceforward to be considered illegal, and the offender subjected to fine and imprisonment."

No mention is anywhere made in the Bible of ploughs being drawn by any other animal than the ox; an old British law forbade the use of other animals than oxen for drawing ploughs, and the early English ploughmen were compelled by law to be as able to make their own ploughs as to guide them. The implement under these circumstances naturally remained for a long time in an exceedingly rude state, and it was not until the commencement of the seventeenth century that anything like an effective implement was constructed. About that time greater attention was paid to agriculture in England, and Dutch engineers came over to drain the fen districts. These intelligent people brought with them the design of that known as the Rotherham plough, so called because the first known to have been constructed in England was made at Rotherham, by Jos. Foljambe, under the direction of the celebrated Walter Blythe, whose works we have often elsewhere alluded to. For this plough a patent was obtained in the year 1730.

Other accounts state that this plough was made by Lammis, upon strictly mathematical principles, which he had learned in Holland—and others, by a person of the name of Pashly, who was ploughmaker to Sir Charles Turner, at Kirkleatham. The son of this last-named person established a manufactory for this plough at Rotherham, and he also is considered by some to have been its original inventor. The design of this plough had, either from Holland or England, found its way to America, and the honour of its invention is claimed by the people of that country. President Jefferson presented an account of the principle for constructing a mould-board, first to the Institute of France, and afterwards to the Board of Agriculture in England, as an original discovery in mathematics.

The Rotherham, or, as it was sometimes called, the Dutch plough, was constructed of wood, with the exception of the coulter, draught-irons, and share; the mould-board was plated with iron, and the sole was also made of the same material. The fame of this plough at length extended into localities remote from where it was originally constructed; and as no very defined form had yet been laid down for it, it may easily be imagined, that in the hands of inferior and prejudiced workmen it degenerated into a clumsy and inefficient implement, while in other and better hands it was improved and altered to suit local circumstances. Arthur Young mentions a plough made by an ingenious blacksmith of the name of Brand, and which he stated as being superior to any other in the kingdom. The Rotherham plough, having found its way into Scotland, was brought under the notice of a most ingenious mechanic, named James Small, born in Berwickshire, in the year 1740. This man bestowed a great amount of attention to the improvement of ploughs, and in the end was enabled to construct one upon a fixed principle, which gave it a permanent and uniform character. Small (remarks Mr. Slight) appears to have been the first who gave to the mould-board and the share a form that could be partially imitated by others, whereby following his instructions, mould-boards might be multiplied, each possessing the due form which he had directed to be given to them. Small's improvement chiefly consisted in giving that most important feature of the implement, the mould-board, a mathematical outline which enabled it to turn the furrows over in an equal and regular manner.

## OF THE PARTS OF THE PLOUGH.

The frame is the centre portion of the implement, to which the mould-board, beam, handles, &c., are affixed; it is now nearly always constructed of iron, and although of different

shapes, according to the peculiar description of plough, its use is always the same, that is, a solid structure upon which to build up the other parts of the instrument, the mould-boards, handle, beam, sole, &c., being screwed to it in such a manner as to be easily adjusted, or removed if necessary.

*The Beam* is a strong bar of iron, or beam of wood, to which the animals are yoked, one end of which is securely fixed to the plough frame, the coulter is also attached to it.

*The Stilts, or Handles*, as the latter name implies, are the long pieces of iron or wood held by the ploughman during the operation of ploughing, and which are so arranged as to give him the greatest possible control over the implement in directing its course, and preserving the depth and accuracy of the work. The one on the right hand side, as the ploughman stands at work, is called the little stilt; this in many ploughs is a continuation of the beam and body of the plough in a straight line.

The left hand one is called the great stilt; both these are attached securely to the plough frame, and often are continuations of the beam, and separated by the stretcher, bolts, and stays.

*The Bridle, Muzzle, or Plough Head*, is a contrivance placed at the outer end of the beam, and to which the horses are yoked. It is constructed in a variety of ways, but the object sought to be obtained in all is the same, that is, to give a ready means of adjusting the line of draught so as to cause it to work steadily, and at the proper depth, by giving it, as it is called, more or less earth; this is effected by means of a moveable portion of the plough head called the *hake*, and which allows of the draught-shackle being altered vertically, more upwards or downwards, or laterally to the right or left. The bridle is differently constructed by different makers, but the usual plan is to make the hake in the arch of a circle, and with a pin secure it in its place, while the draught-chain is regulated in notches cut in the fore part of it.

*The Coulter* is a large knife, made very strong, of iron and steel; it is an important part of the implement, and requires considerable care in its adjustment. Its use is to cut or sever vertically the seam or piece of earth through which the plough is to pass; it is made sharp on the front side, and so strong as not to give or bend in any way while in use. The side of the coulter next the land is perfectly flat; the other side tapers towards the back. To give the necessary thickness and strength, it is attached to the beam of the plough by its upper end, which is made round for that purpose; it is not set perpendicular, but at an angle, generally of about 55° with the ground; but different kinds of land, and the same land under different circumstances, require the coulter to be set at various angles, sometimes very much forward, and at others so far back as to be slightly in the rear of the point of the share, the point being ¾ of an inch above the share, and slightly on the land side of it. The manner in which the coulter is secured to the beam is different in the various descriptions of ploughs. The ordinary old-fashioned plan is by a wedge; but this was very inefficient, difficult, and uncertain. Messrs. Ransome, and other makers, adopt a principle of adjustment which gets over much of the difficulty. Messrs. Hensman have a screw and lever, which is attached to the side of the beam; and thus the coulter is set more forward or backward as may be required.

*The Sock, or Share*, is that part which cuts the slice of earth horizontally; it is fixed into a projecting portion of the lower part of the plough body, called the *sole or slade*, which is a moveable piece secured to the under side of the frame.

Plough-shares are not always of the same form, being more or less curved on the face, and longer or shorter pointed.

Plough-shares were formerly made of wrought iron, but

in 1785, the late Robert Ransome, ot Ipswich, obtained a patent for constructing "shares of cast iron."

This was a most important improvement, and caused all parts of the plough to be equally improved by the same gentleman and others; and in 1803, Robert Ransome still further improved the manufacture of cast iron shares, by applying a case-hardening process to them. They are now manufactured by the firm of Ransome & Co., of Ipswich, in large quantities. Their improvements consist in case-hardening the under side the thickness of $\frac{1}{10}$ or $\frac{1}{8}$ of an inch, thus resembling the effect of placing there a layer of steel. The lower part, from its hardness, wears slowly, while the upper part grinds quickly away. A uniform sharp edge is thus constantly kept.

*The Mould-board* is now invariably a plate of cast iron, screwed to the plough frame, and is also called the turn-furrow, or wrest.

This term originally applied to only a portion of the mould-board, and was probably the wrest of the ancient plough which turned aside the earth, after it had been cut by the coulter. The part called the wrest, in the Kentish plough, is simply a bar of wood.

The office of the modern mould-board is to receive the piece of earth upon its fore end after it has been cut by the coulter from the side, and from the bottom by the share, and then turn it over continuously to a fixed angle, which it does by its peculiar curved form, these curves being continued from the mould-board by the form of the box end of the share to its extreme point.

It is upon the correct form of this part of the implement that the accuracy, ease, and excellence of the ploughing will depend. The largest amount of attention, therefore, has been devoted to it; and desirable as it is that some fixed principle should be laid down as applicable to all forms of mould-boards, it has not as yet been accomplished, though

the principles by which it is governed have been investigated and discussed by a great number of scientific and talented individuals, from Small's time till now. Among these may be mentioned, Bailey, Gray, Jefferson, Clymer, Ransome, Wilkie, Rham, Slight, and others, who, though not arriving quite to the point required, have nevertheless, by their consideration of the subject, been able to lay the foundation for some rules that may soon be adopted for the production of a comparatively perfect form of this important part of the plough; not that it is likely that any one form will ever be the best for every description of plough, and for all the circumstances under which ploughs are used, as width and depth of furrow are not the only change of circumstances, and it is well known that a mould-board which exhibits an evenly-worn, polished surface, and all the marks of having been well adapted to its work, will, on being removed to another description of soil, exhibit quite the reverse features, and show its entire unfitness for the purpose.

It is impossible in the limited size of this book to enter at length on the details of the various forms of mould-board in use,—nor is it necessary, as this work is intended for farmers, and not ploughmakers; and parties purchasing ploughs of those persons who have obtained a character for the efficiency of their implements need not trouble themselves much about it, as they may rely upon such ploughs as are sold by Messrs. Ransome, of Ipswich, Howard, of Bedford, Busby, of Bedale, and many other persons, being constructed with every care and attention to all the qualities necessary to produce an implement thoroughly well adapted to its purpose. The repeated trials for the premiums offered by the Royal Agricultural Society have done much towards improving ploughs, and their results are the data which the agriculturist can study to increase his store of knowledge in this department of agricultural machines.

## WHEEL AND SWING PLOUGHS.

Ploughs are divided into two classes respectively, called Wheel and Swing Ploughs.

Those of the former class are usually fitted with a carriage and two wheels to support the beam, which is then made to stand up at a considerable angle, and is secured to the upper part of the carriage, as shown in fig. 8; the body, frame, stilts, coulter, &c., being similar to a swing plough. The draught chain is attached to the centre part of the frame (which is called a gallows) between the two wheels, and should be at precisely the same spot as it is in the swing plough, the beam of which is always curved downwards to allow of it.

Ploughs with a wheel and a high gallows, are common in many parts of England, and are generally much preferred by the local farmers. Varieties of them may be met with in Norfolk, Essex, Berkshire, Wiltshire, and many other counties. The Kentish turn-wrest is one of the most celebrated of this description, but has its own peculiar turn, turson, or wrest. The Hampshire wheel plough is peculiar to some of the light sandy ground in North Hants, and has some peculiar (local) advantages. In North Wilts, in the neighbourhood of Chippenham, a wheel plough is used, and preferred to any of the long mould-board ploughs lately introduced; it is called *the Wiltshire Dilly Plough*. The best specimens of this are made by a very excellent and ingenious implement maker, named John Berriman, of Lyneham, the grandson of the original inventor. They are wheel ploughs, but are without the gallows or front carriage. I have not sufficient knowledge of this implement to be able to describe the peculiar qualifications it possesses to make it so great a favourite in its locality, but certain it is that this

homely machine is preferred to the most scientific modern ones. It is also extraordinary that a wooden mould-board is used for it, made of a thick block of apple or pear tree, and dubbed into shape with an adze, entirely guided by the eye; but such is the skill of the maker, and the experience acquired by constant practice, that a very perfect form is given to it.

Iron mould-boards are fitted to it, but they are not so well liked by those who use them.

A number of ploughs, of an intermediate character between beam and swing ploughs, have also been introduced. Some of these displayed great ingenuity in their construction; one class had wheels or a wheel attached to the plough frame, and was intended to decrease the friction of the spade or sole-shoe upon the surface of the ground while the plough travels; and although there is some degree of plausibility in the idea, the disadvantages of the old plan are not so great as the inconveniences of the improved one, consequently none of them have come into use.

*The Beam Plough, with Land and Furrow Wheel,* is a successful attempt at combining some of the advantages of both descriptions of ploughs into one. Many Scotch ploughs are now made in this way. The plan was not originally introduced in Scotland; nevertheless they are called the improved Scotch ploughs, though Scotch ploughmen will be found invariably to prefer swing ploughs to any other descriptions of the implement.

*The Rutland Plough* is a good specimen of one of this class. It was designed and originally introduced into the county from which it takes its name, by Richard Baker, of Cottesmere. These ploughs may be used as either swing or wheel ploughs, the wheels being easily removed. Nearly all the most approved English are now made in this manner.

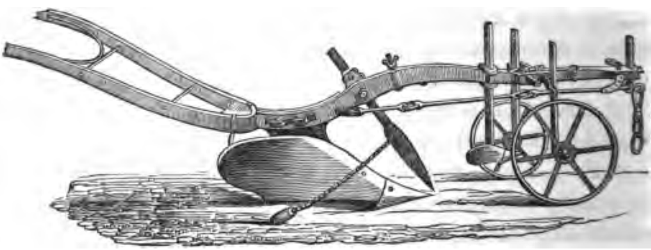
Fig. 6 shows the manner in which the wheels era attached.

Of the comparative merits of wheel and swing ploughs, much has been said and written by many persons interested in the subject; and the balance of evidence thus given in favour of each is decidedly on the side of the wheel plough, or rather the land and furrow wheel-plough, one wheel of about 20 inches diameter running in the furrow, and the other one of about 12 inches running on the top of the unploughed land—the width of the wheels apart may be adjusted to suit any width of furrow.

### HOWARD'S PRIZE PLOUGH.

This plough is made of iron (principally wrought), and is intended for ordinary ploughing, and is the smallest of a set of new ploughs recently designed and patented by G. J. and F. Howard. The new patent ploughs are made prin-

Fig. 6.



cipally of wrought iron, and are all improved from their prize ploughs. They are made of three sizes, marked for distiction X., XX., XXX., suitable for ordinary, deep, and extra-deep ploughing.

The improvements consist in greater elegance of design, more equal proportions, and the furrow-turners being made particularly taper and regular in their curve, and formed

upon exact geometrical principles. The furrow-slice is thus made to travel at an uniform rate, from its being first cut until left in its final position; the power required to work the implement considerably lessened, and the furrows laid more evenly, and in the best form for the reception of the seed, as well as working much cleaner upon land inclined to adhere, or load to the breast, or furrow-turner. The shares are fixed to lever nicks of wrought iron (made upon an improved principle), the raising or lowering of which gives the point greater or less "pitch," or inclination, as the share wears, or as the state of the land may require. The superiority of this lever neck over others is its great simplicity, and its being tightened at the end, instead of by a bolt through the side. When raised or lowered (which can be done instantly), it is secured in a series of grooves; the iron is thus brought into a state of tension, ensuring firmness as well as increasing the strength. The centre pin, upon which the lever works, is a fixture to the neck, and takes its bearing close to the head or socket of the share, so that the top of the share is not raised above or below the front of the breast, when moved into the higher or lower grooves. The lever neck has another great advantage over any other, —the accumulation of earth inside the plough, in most instances, renders the lever useless, as it cannot be moved without a great deal of trouble; but in this arrangement, by simply taking off the end next the neck, it may be at once disconnected from the plough, and anything preventing its free action removed. The axles of the wheels are upon a new principle, and are made so that no grit can enter, nor any oil or grease escape: the wheels, therefore, will wear much longer, the axles require little or no repairing, and the friction is considerably reduced. The mode of fixing the wheels is also peculiar; the holdfasts or clamps securing them are made to slide through a mortice formed in the beam, by which the width may be altered with greater

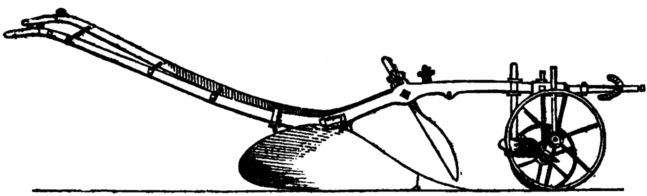
facility, besides dispensing with the old sliding axle, which was an obstacle in deep ploughing, and objectionable on dirty land, on account of the soil accumulating round it. The wheels of the method now adopted are brought opposite to each other, and the land-wheel may be expanded as well as the furrow-wheel. A draught-chain is adopted in all Messrs. Howard's ploughs, for the following reasons:—It removes all strain from the beam, and in land-work there is a steadiness of movement not to be found in ploughs which draw from the end of the beam; the line of draught is also more direct, consequently the power required is reduced. The handles and beam, which are of wrought iron, are made throughout in a piece, preventing their shaking loose, which is the case with most other ploughs made of iron. This latter improvement also prevents the accumulation of soil in the hinder part of the plough. Every part is so arranged that a ploughman can remove or replace the irons, subject to wear or breakage in the field, without the assistance of a mechanic. It can be worked either with or without wheels, or with one, as required. It may be had with breasts or furrow-turners of various sizes and shapes; broad shares may also be had with it, for paring stubble or turf, and others of triangular form, for subsoiling and ploughing between the rows of beans or root-crops. The skim coulter with which it is fitted is of great importance when ploughing ley ground and stubble; it precedes the common coulter, paring and turning into the furrow the herbage upon the surface, so that when the soil is turned over by the plough nothing of grass or weeds is left to grow out between the furrows; consequently the vegetable matter thus buried, instead of living upon the soil, decomposes and serves to enrich the land. It will also be found most useful when ploughing in dung, mustard, tares, &c., for with the addition of a "drag-chain," all may be turned in completely. —*Catalogue of the Royal Agricultural Society at Lewes.*

## BUSBY'S PRIZE PLOUGH.

This plough had the council medal awarded to it at the Great Exhibition of all Nations in Hyde Park, in 1851.

It is manufactured by Mr. Busby, of Newton-le-Willows, near Bedale, Yorkshire, who has, by his intelligence and

Fig. 7.



untiring industry in the manufacture of this and other implements, raised himself from an ordinary workman to his present position as the recipient of the highest honour it was in the power of the Commissioners of the Great Exhibition to bestow.

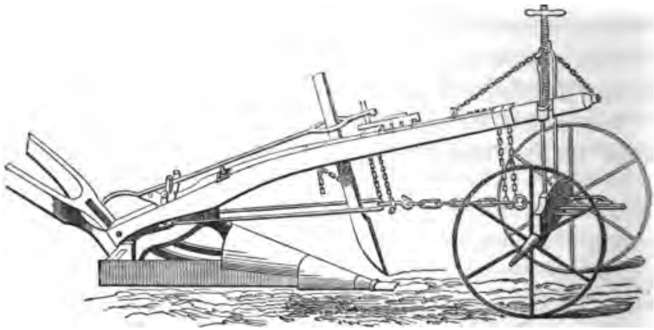
This plough has been introduced as the best specimen of a plough that is at present manufactured.

## THE KENTISH TURN-WREST PLOUGH.

A stranger passing for the first time through the county of Kent could not fail to notice this remarkable machine. In appearance it is the ugliest, heaviest, and most cumbersome-looking machine to be found in all England, yet in practice I have no hesitation in saying that it is

one of the very best ploughs the agriculturist will ever meet with.

Fig. 8.



Boys, in his survey of Kent, gives the following dimensions and description of the implement :—

"It consists of a beam of wood, 10 feet long by 5 inches deep and 4 broad, behind which is a foot 5 inches by 3½ feet long, on the top of which the stilts, or handles, are placed; the foot is tenoned to the end of the beam, and mortised at the bottom to the end of the chep. Through the beam, at 2 feet 5 inches distance from the foot, is a sheath of oak, 7 inches wide by 1½ thick, which is mortised into the chep, or sole, in an oblique direction, so that the point of the share is 22 inches distant from the beam. The chep, to which the share is fixed, is 5 feet long, 4 inches wide, and 5 deep. The share is of hammered iron, weighs about 32 lbs., is 20 inches long, and from 4½ to 7 inches wide at the point. The upper end of the beam rests on a carriage, with two wheels, 3 feet 2 inches high. On the axle-tree is a gallows, on which is a sliding bolster, to let up and down. Through the centre of the axle is a clasp iron, to which is fixed a strong chain, called a "tow," that comes over the beam, so fixed as by means of notches (or a pin called a "chick"),

to let the whole plough out a greater length from the axle, thereby letting it down to a greater depth."

Marshall's description of this plough is too good to be omitted. He says it is almost impossible to describe this extraordinary production verbally, for its component parts, and the names assigned them, are equal to those of a ship. A North of England farmer, who has never been south of the Thames, would little suspect the purpose for which it is constructed; he would conceive it to be a carriage rather than a plough. It has a pair of wheels fully as large as the fore wheels of a moorland waggon, and behind them is dragged a long thick log of wood, which slides upon the ground as the hob or shoe of a sledge, with a beam rising high above it, which a small farmer of the north would be glad of as a gate-post; comprising in its various parts as much timber and other materials as would build a Highland cart. It is so peculiar an instrument as to be manageable only by a person who has been long trained to the use of it; and so liable to dislocation from a conflict of forces in its mechanism as to require continual nailing and tinkering on the part of its manager; and so unwieldy and rebellious on some of the hill-grounds which most require the turn-wrest form of tillage as to have been known to break away bodily from even the most careful and practised control. Yet, in spite of its many and enormous disadvantages, it possesses such eminent adaptation to the chalky hills and absorbent plains of Kent, and Surrey, and West Sussex, as to have maintained its place in the firm and general esteem of the farmers of these districts age after age, since at least the beginning of the seventeenth century, to the utter neglect of the great multitude of modern plough improvements. The value of it on such lands, says the writer whom we have already quoted in this paragraph, is so obvious at sight that I claim no merit in having repeatedly recommended it in the West of England, the central Highlands, and other

places, for steep surfaces and absorbent subsoils. Even on level ground, whose subsoil is of an absorbent nature, this plough has its merits; and in breaking up whole ground to be cropped on one ploughing, as old sward, temporary ley, stubble, and especially where the soil is of a strong tenacious texture, it is a valuable instrument. The share being merely a socket, with a flatted point or chisel, without any fin or wing to separate the soil from its base, it is of course torn from it by strength of team, and in this violent operation the texture of the soil is broken so as to admit the tender fibrils of the succeeding crop. Add to this, the plit or plough-slice adhering strongly on the furrow-side, is turned with difficulty.

The Kentish turn-wrest plough, in spite of its ugly appearance, is considered by the best judges to be (when in the hands of skilful ploughmen) a most efficient implement; and I remember to have once heard the first ploughmaker in England (and he lives at Bedford) say he considered Kent the best ploughed county in England.

The man who attempts to plough with this implement must thoroughly understand all its peculiarities, and be able to adjust it to the greatest nicety, for as it has to lay off both right and left, it must be perfectly true in all its bearings, and the coulter must set quite true to the furrow-edge it is cutting. What Marshall calls the nailing and tinkering on the part of its manager is caused by correcting any inclination the machine may have to swerve from a perfectly straight line, and which the complicated bracings necessary may cause it to do. The experienced ploughman, therefore, always carries in the foot of an old shoe, or a small leather bag, a quantity of nails of various sizes; these he fits in at the junction of the links with each other until the whole arrangement is to his mind. At ploughing-matches, it is no uncommon thing for the ploughman to fit in between twenty and thirty of these nails before he is

sufficiently satisfied with the general trim of his machine to commence operations.

Mr. Ransome observes that the work performed is excellent, and for deep and heavy ploughings, the principle is better adapted than a casual observer would suppose; but that it is not to be denied that it is a more cumbrous implement than a plough formed as a turn-wrest needs to be, for a large proportion of its present size and strength is requisite to provide against the strains to which it is subjected from the attempts to counterbalance the conflicting forces its erroneous construction has engendered. With a view to bring this plough into more general use, by getting rid of some of the least useful portions of it and remodelling of the others, a plough was constructed under the direction of Mr. William Smart, of Rainham, in Kent, and with such success that the improved plough might be made equally applicable to the power of two or four horses, according to the state or nature of the land on which it was to be used. In Vol. XIII., p. 59, of the "Farmers' Magazine" will be found a lengthened description of these improvements, and the views of the constructor in reference to the turn-wrest plough. Smart's plough is so constructed that the ploughman can shift the coulter as he pleases, and reverse the wrest from right to left without moving from his proper position between the stilts; this he effects by means of a lever through which the head of the coulter passes, and one end of which is brought conveniently up to a position just above the inner end of the plough-beam; and by a simple mechanical contrivance the turn-wrest can be removed from side to side, so that either becomes alternately the mould-board as the furrow requires to be turned. A screw-link and swivel is introduced in the chains to get rid of the nail business before mentioned. This plough in its improved form is manufactured by Messrs. Ransome, of Ipswich; the handles and beam are of wood, and the gallows of wrought iron.

There are a variety of other ploughs for effecting the same object as the one we have been describing, that is, the turning the furrows all in one direction, and laying the seams at an angle with the horizon. One of the first of these was invented by the late Mr. Smith, of Deanston; it was framed much like an ordinary iron Scotch plough, but had two mould-boards, one of which was elevated above the beam, while the other is at work. On arriving at the end of the furrow, the right and left handed mould-boards are reversed, by means of a handle fixed to the end of a spindle, placed longitudinally along the beam above the plough-frame; and on the end of this is placed an eccentric ingeniously contrived, by James Wilkie, of Addington, which, acting upon the coulter, sets it to the proper angle for the land side of the furrow, right or left, as may be. It obtained a premium from the Highland Society twenty years ago, and serves equally well for ploughing on the sides of the steepest hills as on the flat. In Mr. Ransome's book this plough is described as invented by James Smith, of Deanston. In other books it is called Wilkie's double mould-board turn-wrest plough. There was an implement in existence before this, exhibiting essentially the same principles, but was not nearly in so perfect a state. It was invented by Gray.

*Hay's Turn-wrest.*—This was the invention of Captain Hay, of Belton, and was peculiar: it had a right-handed body, and a left-handed one, placed end to end, its beam and stilts turning on a pivot at the centre of the top of the body, thus easily reversing, and turning the furrow right or left; its coulter is fixed to the beam in the ordinary manner.

*Huckvale's Plough* is thus described by Ransome. This plough is so constructed, that by reversing the position of one of its handles the ploughman is enabled to turn the body part from right to left, so that the part that was in one instance the slade or sole of the plough, will alternately become its land side, and thus act on either side of the plough;

that side which is not at work forming a close cover over the other. The share is formed with two blades or cutting edges at right angles, one of which acts horizontally as a share, and the other vertically as a coulter, and the position of which is changed at each end of the furrow by the same operation.

*Read's Turn-wrest.*—The improvement consists in the application of a pair of wheels, or a single wheel, as a roller, as circumstances may require. The leading wheel or wheels run on a plain surface of the land, and regulate the depth of the plough. The hind wheels are placed under the sole of the plough, commonly called the chep, and carry the hind part clear of the ground, by which means the great unnecessary friction arising from dragging the whole length along the furrow is greatly diminished. It is also applied to a mole-share, fitted to follow the hind wheels. This plough, with the mole-share acting 5 inches below the furrow, opens the pores, through a stratum of earth that has been trodden for the last century (by driving horses in the furrow), until it became nearly as impervious as a sheet of lead. It has, with the mole-share attached, been drawn by four horses for a whole day, ridging up wheat upon very stiff lands. Where land has been drained ridging is unnecessary; the surface of the field may be left plain, without furrows. To accomplish this, the ground-wrest is taken off at the end of every furrow, and shifted to the other side, while the horses are turning, and the coulter shifted by means of a lever at the top of the beam. The snap-wrest is not taken off to turn the furrow, but passes through the body of the plough; the lever shifts the coulter the same as the turn-wrest.

## LOWCOCK'S PATENT PLOUGH.

This plough is for the purpose of turning furrows in one line of direction, and parallel to each other. It is almost

self-acting, as respects its adaptation to each succeeding furrow; and so simple in its formation that any ploughman may at once use it to advantage.

It will be seen upon inspection that the plough does not require to be turned round at the end of the field; but the ploughman having completed his furrow, to the right, passing on the furrow side of the plough, turns over the handles from one end of the beam to the other, when they are re-adjusted by a catch affixed to them, which, dropping into a mortice at the beam-head, renders them stationary. Whilst performing this simple operation, the horses turn round on the land side of the plough (thus preventing the ploughed land from being trodden), and by the act of turning, the draught-chain to which they are attached slides on a rod to the other end of the plough. As soon as the horses commence drawing, the left-hand share and coulter set into their work; the double fly, which forms a part of the mould-board each way, coming in contact with the newly-cut furrow, instantly turns back and assumes its correct position, and the implement proceeds without further adjustment, cutting out and turning over the furrow-slice to the left hand. The utility of a plough of this description is obvious, whether for ley crops, in small, irregular, and hilly fields, or in lands that will not bear treading when wet.

## CLARK'S UNIVERSAL RIDGE PLOUGH.

Is the invention of John Clark, of Long Sutton Marsh, to whom a medal was awarded by the Royal Agricultural Society of England.

It is adapted to the several purposes of ridge culture, and by an easy transition of shape, which is accomplished in a simple manner, it becomes,

1st. A double tom or ridge plough, for opening or closing the soil, as in ridge-ploughing, or for setting out the land for

ordinary ploughing, or for opening the surface-drains in water-furrows, &c.

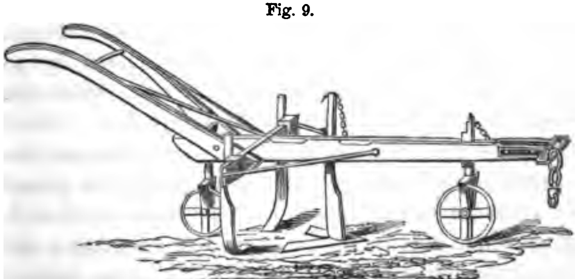
2nd. A moulding plough for moulding up roots, crops, and other purposes.

3rd. It may be converted into a horse-hoe or cleaning plough, with curved coulters, for cleaning the sides of ridges, or with flat hoes for broad work; or it may, with slight modification, become a broad-share plough, to which rising prongs or shares may be attached, for the purpose of clearing land from weeds and rubbish. This implement is exceeding well adapted to small holders who cannot afford to have a great variety of implements lying idle for a large portion of their time. Machines and implements of all kinds, whether mills, ploughs, &c., that are adapted to execute a variety of different operations, are deserving of special encouragement, as being so particularly adapted to the wants of the small farmer, who, without them, is working at great disadvantage with his neighbours, whose operations are on a much larger extent of ground.

## RANSOME'S HOE PLOUGH.

Is for the purpose of hoeing up weeds, and stirring and loosening the soil between the rows of plants. It has two wheels, one in front, and one behind the hoes, by which the

Fig. 9.



depth of hoeing is regulated. It may be used with three triangular hoes, each cutting $13\frac{1}{2}$ inches wide, extending over 3 feet 6 inches, or contracted to a smaller width; or the two hind hoes may be substituted by two curved knives, as shown in fig. 9, for cutting the weeds up on the sides of ridges. It is a very simple implement, capable of doing a great deal of work, and may be adapted to a variety of purposes.

## MOULDING PLOUGHS, OR DOUBLE TOMS.

These are made with two mould-boards, one on either side, and are used for earthing up plants sown upon the ridge; the mould is turned up lightly on the right and left sides, as the plough passes along between the rows. It is also frequently used for opening water-furrows between the breadths of ploughed land. When the mould-boards are removed, it may be applied as a broad-share plough for cleaning land, or as a light description of subsoil. They are manufactured by Messrs. Ransome of an improved form, and may be adapted to a variety of useful purposes, with the addition of some very simple parts.

## THE DOUBLE FURROW PLOUGH.

Is an implement of such ancient date that it is mentioned by Walter Blythe, who wrote during the protectorate of Oliver Cromwell; but was not extensively brought into use until it was recommended by some improvements of the late Lord Somerville, whom many persons have viewed as its original inventor. The late Mr. Billingsley, of Shepton Mallet, says that some may doubt the possibility of making the double plough so generally useful; but he can truly say that he never yet found an instance where it could not be worked to advantage; and it is well known that, in the various trials made under the

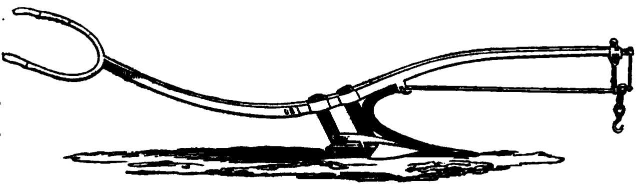
auspices of the Bath Society, on lands of the most difficult nature, the double plough has always gained the prize. It has been recommended by judges, when drawn by four horses, and put in competition with a Norfolk wheel plough, a light Carlisle swing plough, and a common Wiltshire plough, each drawn by a pair, "as the best and cheapest for general use;" the decision also stating "that the double coulter plough had been preferred for the general purposes of husbandry, laying the furrow more flat than the others, and consequently exposing more new surface to the influence of the elements, and preventing more completely the growth of grass and weeds between the furrows." Although on light soils it may be used with considerable profit, if the ground be tolerably level, yet if the surface be very uneven, it works to disadvantage; nor can it be properly worked on land that has not been previously broken up, and it can be of very little use where it is the custom to raise the crown of the ridge considerably above the furrow, since it cannot perform the operations of "gathering or cleaning." Double furrow ploughs of an improved form are manufactured by Ransome and May, of Ipswich.

## SUBSOIL PLOUGHS.

The practice of subsoiling has been productive of perhaps greater immediate benefits to the farmer than almost any improvement that has been introduced of late years, for subsoil ploughing is the breaking up the stratum of earth immediately under that which is annually ploughed and prepared for the growing of crops, and upon which the horses have, ever since the ground was first cultivated with a plough, been walking, so treading it into an impermeable mass, through which the water cannot pass but with difficulty, or the roots of the plants force their way. If subsoiling be well done it will generally repay its cost the

first year, as the soil broken up has through time been receiving much of the fertilising matter laid on above, and a heavy crop is sure to be the reward for the expense incurred; but I would advise all persons about to subsoil

Fig. 10.



land, especially if there be a pan or crust to break up, to employ some person whom they can trust (the farmer himself ought to do it) to walk beside the plough the whole time the operation is going on, and continually with a spade examine the soil, and see if it be effectually broken up. Unless this be done, I am sure the work will not be properly executed. I have tried all sorts of men at the subsoil plough, and never knew an instance where the ordinary ploughman would keep the plough down, if he could avoid it; in nine cases out of ten he believes the whole operation to be a new-fangled idea from which no benefit will be derived, and if his horses are good, and he takes much pride in their sleek condition, he will certainly sacrifice the efficiency of the operation for the benefit of his favourite animals. The master must never leave the plough, and must always insist that the depth decided on be kept, never minding how much the man complains of himself and his horses, and always remembering that it is better to do a small piece thoroughly well, than to run lightly over the whole farm. Subsoil ploughs have been used and appreciated for many years; the first mention made of one is in "Worlidge's Mysteries of Husbandry," 1677. He tells of an ingenious

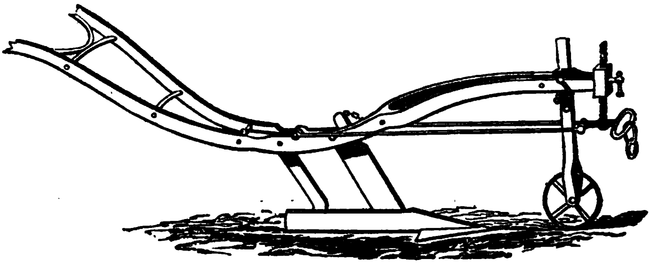
young man in Kent who had two ploughs fastened very firmly together, by the which he ploughed two furrows at once, one under the other, and so stirred up the land 12 to 14 inches deep. This is clearly a regular subsoil operation; but no such practice became general, until James Smith, of Deanston, had invented a proper plough for the purpose, and pursued subsoiling as a regular tillage operation. His plough is by far the best known and appreciated of any of the deep working ploughs. Fig. 10 represents this implement; it has no mould-board nor land side-plates, and is in fact only a skeleton plough of great strength.

A longitudinal feather stands in the place of a mould-board; it has a strong pointed share, with a flat feather; it has also a curved and self-cleaning coulter. The draught is applied through a bridle and chain bar. Mr. Smith says it is intended merely to break up and stir the subsoil, without bringing it to the surface, or mixing it in the first instance with the superincumbent soil; it is in fact a horse pick, and readily loosens and throws out all stones, not exceeding 70 lb. in weight. It is drawn by four horses, two and two abreast, and is held in the usual way by one man. In working, the common plough goes before it, taking a furrow 10 inches by 6 inches, the subsoil implement following in the bottom of that furrow, and going deeper by 10 or 12 inches.

### THE BACKHEATH SUBSOIL PLOUGH.

This is the invention of Sir E. Stracey. It is of a lighter description than the Deanston plough, and effects its object

Fig. 11.



in a satisfactory manner. When fitted with wheels it makes a most valuable subturf plough, and is useful in a variety of ways.

### THE CHARLBURY SUBSOIL PLOUGH

Is the invention of Philip Pusey, Esq., M.P., and is intended as a substitute for the Deanston plough. Mr. Pusey's improvements are described by him in an interesting paper in the *Journal of the Royal Agricultural Society*, vol. I. p. 433. He says, "It struck me, therefore, that possibly the discovery of Mr. Smith might be carried a little farther, and be brought more within ordinary means, if we could diminish the friction necessarily incurred in passing through the unstirred subsoil by dispensing with more parts of the common plough besides the mould-board; and I determined to try whether, by combining in one plough the two hitherto used, we might not get rid of the sole itself in the underground implement, trusting to the ordinary sole above ground for preserving the balance, and so reducing the instrument below the furrow (where the

friction and resistance are, of course, very great), to a mere cutting or stirring-tool.

The experimental plough was constructed by Hart, of Wantage, by placing a strong iron socket behind one of his own single-wheel ploughs, constructed with greater strength in the beam than usual; into this socket a tine, similar to those of Biddle's scarifier, but thinner, was placed. This back tine could be raised or lowered at pleasure. It was placed on the off-side of the beam, in order that it might work in the middle of the fresh furrow, and so act more freely than if it was placed on the near-side, immediately against the unstirred land.

A trial of the draught of this plough was made with Mr. Cottam's draught gauge, and found to be between 7 and 8 cwt.; while the draught of the Deanston subsoil was 12 cwt., and adding to which 2 cwt. for the plough that first opens the furrow, the labour of the horses would be equal to 14 cwt. altogether. Mr. Pusey states that the subsoil was more thoroughly stirred by the Deanston implement; but that one of the principal objects of subsoiling—the letting the water down to the drains through clefts left in the subsoil—was accomplished equally with his plough as the the heavier one.

## BARRETT, EXALL, AND ANDREWS'S SUBSOIL PLOUGH.

The mechanical construction of this plough is simple, and in practice it is found to work lighter than the single-share plough. It is constructed with two or three tines or shares, so adjusted in position, and formed of such shape, as would most easily overcome resistance; each share, preceding its follower, lessens its work by breaking up the upper crust of the soil, and the lower share can either be shaped as an O or ◠, so leaving an arched drain to carry away the top water to the main drains.

## READ'S SUBPULVERISER.

This is a very useful and efficient implement, and should be in constant use on every farm, for it is one of the best subsoil ploughs ever made.

At the meeting of the Royal Agricultural Society at Southampton, this plough was put to the test by the judges, with several others, in the hard-baked soil of Mr. Spooner's farm. The pan, or old plough-floor, of this field had evidently never been invaded by agricultural tools. Below six inches it was as solid as continual trampling can be conceived to have made a tenacious loam, aided by a drought of several weeks' duration. Mr. Read's pulveriser was put into the furrow opened by a plough, and set to work at about six inches under it. To use the judges' own words, "the old floor was split into fragments like broken tiles, and the soil separated and pulverised."—*Royal Agricultural Society's Journal*, vol. V., Part 2, p. 371.

I have used this plough much myself in breaking up moor-pan, and can confidently recommend it as a generally useful implement. It may be adapted to a variety of purposes by substituting different formed shares and tines, and used as a turf-plough, grubber, horse-hoe, &c., &c. It is sometimes made with wooden beams and stilts, and at others with Stratten's patent hollow-iron beam. In the latter form it is much stronger and more durable.

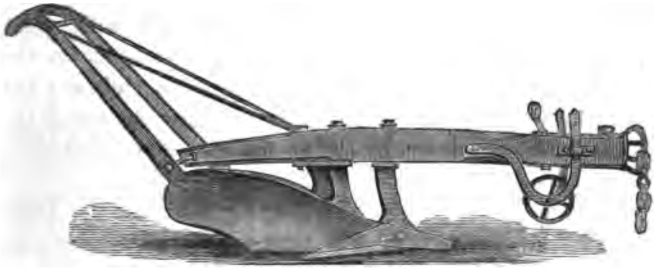
## AN AMERICAN PLOUGH.

This is a representation of one of the American ploughs exhibited at the Great Exhibition of all Nations, and which excited great interest among agriculturists who saw them.

They are said to possess peculiar advantages in the locality of the lands they are intended to break up; but they are not

available here in any way that I am aware of, though I observe one house advertises to supply English farmers with these

Fig. 12.



remarkable implements. I doubt much whether any one who has seen the ploughs of our best makers will ever be persuaded to buy them, so utterly different are they to all those notions which we are agreed about in reference to ploughs.

Some very ingenious implements were exhibited nevertheless—one, in particular, which was so constructed that the mould-board turned underneath and adapted itself equally well to one side or the other; and, among others, one which has chisel-headed shares, which could be protruded forward as it wore away, being thus always self-sharpening. This principle might be applied with advantage to ploughs intended for the colonies.

## PLOUGHING BY STEAM

Has not yet been brought to such a state as to be applicable to ordinary practice. A number of gentlemen have, at different times, brought forward plans for ploughing by steam, and, much to their honour, have given the different methods a fair trial without regard to the expense; and so far as the mere fact of the practicability of ploughing by

steam is concerned, it has been accomplished—whole fields having been well ploughed, in a number of different trials conducted by Mr. Heathcote and other gentlemen.

Some of the most recent of these have been made by Lord Willoughby d'Eresby, at Grimsthorpe, and with great success. In this case a portable engine works down the centre of the field upon a sort of portable railway; the ploughs work backwards and forwards between it and the side of the field, drawn by chains and windlasses worked by the engine.

At a recent meeting of the Royal Institution, the Duke of Northumberland in the chair—J. Wilson, Esq., on Ploughs and Ploughing, ancient and modern. Mr. Wilson, after a general history of ploughs, summed up as follows:—

"Let us see what would be the result of the substitution of the steam plough for our present systems of ploughing. In England, taking Caird's estimate, there are 14,000,000 acres in tillage; these are ploughed certainly once every year. The cost of the operation averages at least 10*s*. per acre, thus giving a total of 7,000,000*l*. per annum. This first machine of Usher does the work better than by the plough for 2*s*. 6*d*. per acre, or at 75 per cent. less cost. The saving would consequently be about 5,250,000*l*. per annum. The labour of 50,000 men, and 100,000 horses, required for this one operation, would be replaced, and a saving in the consumption of corn effected to at least 1,500,000 quarters, which would be thus rendered available for the more direct wants of the community."

# CHAPTER III.

## HARROWS AND CULTIVATORS.

The next operation after the plough is that of harrowing. It requires to be performed at different times on all descriptions of land, for pulverising and reducing the clods of stiff land, and extracting couch, &c., upon light. It is required for preparing the land for sowing, and is used for covering the seed with the earth after the crop has been sown.

This implement is of equal antiquity with the plough, for an instrument of this kind must have existed in some shape or other from the earliest periods in the history of agriculture; for as the opening up of the soil required the aid of the plough, so did the covering up the seed the assistance of another implement of entirely different character. A branch of a tree was doubtless the first instrument used for the purpose, and in the early operation upon the soil, little more would be required than such an implement would perform; indeed, so lately as 1668, an agricultural writer gives directions for constructing a harrow, thus:—"Get a pretty big white-thorn tree, and make sure that it be wonderful thick, bushy, and rough-grown." In many parts of the world, at the present time, no better harrow exists. In Norway, Russia, and other countries where fir-trees abound, the harrows are generally constructed by fastening several lengths of tree side by side, with a cross-piece on the top to hold them together. As they are drawn along, the projecting spurs act as tines, and the trees roll about as they are drawn forward, and effect the operation of harrowing in a much better manner than might be supposed. A similar imple-

ment, of a lighter kind, is also constructed by fastening the fir-logs across the opposite way. The Belgian Hacken is formed of thick spars of wood fastened together, but it has no teeth. A framework of wood and wooden teeth may be found in some remote farms in England at the present time; the introduction of iron teeth is comparatively a modern improvement.

The harrow performs its work by means of the teeth, or tines, as they are called, pressed into the soil by their own weight and that of the frame to which they are attached. They are made of a variety of shapes and weights, according to the description of land on which they are to be employed. The heaviest kind are called drags; and the smaller, harrows. The drags are used singly, or two coupled together; the light harrows are worked in gangs.

The drags are constructed with tines from nine inches to a foot in length, and are securely fastened to a wooden framework composed of cross bars, the strongest of which are called the balks or bulls, and are placed lengthways in the frame.

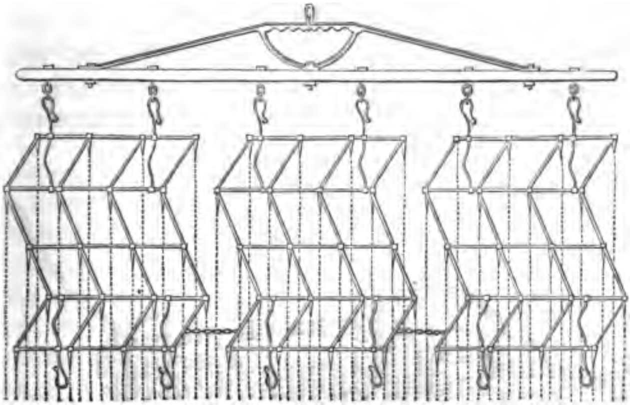
The tines are sometimes made like plough coulters, and rake considerably forward. A pair of wheels have also been fitted to them, and an arrangement made to adjust the depth of the tines; but when thus treated the implement approaches nearly to the grubber and scarifier (which will be found described under their respective heads), and many of the operations formerly performed by drags are now done in a much more efficient manner by some descriptions of the latter implements.

Small harrows are always worked connected together, or in gangs, attached to each other in a variety of ways by links, so as to allow them sufficient play to yield to the curved form of the ridges, and thus perform the work very completely.

Howards, of Bedford, are celebrated for the manufacture

of harrows of all kinds, more particularly those on the principle invented by W. Armstrong, and shown in fig. 13.

Fig. 13.



In these harrows the teeth are so arranged that each cuts a separate track, at equal distances; the draught is from a centre, so that any irregular pace of the horses does not affect them by drawing them out of their proper track. The balks are of zig-zag form, which allows of the tines working in lines very close to each other, yet preventing any inclination to clog.

Each harrow is attached to the whippletree by double hooks, which prevent them, in rough work and turning, from riding upon each other, and also, when working upon the side of a hill, from inclining towards the lower ground. They are furnished with hooks at the hinder part, in order to draw them the contrary way when harrowing-in seed or crops in the spring; by this means the soil is not rooted up or penetrated so deep as when drawn forward in the usual manner.

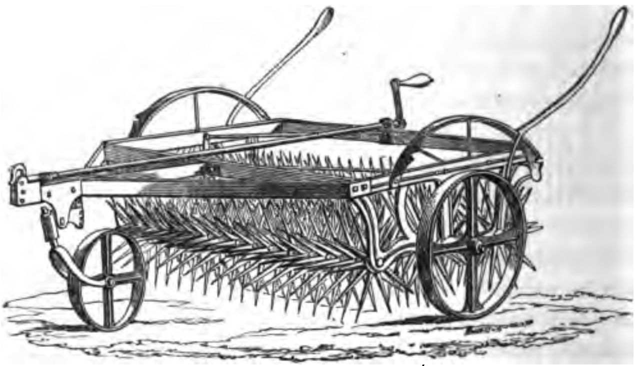
The teeth are made with a square shoulder, and secured to the frame by means of screws and nuts; consequently they

may be taken out and re-laid without injuring the frame or beams. Each tooth is secured with a double nut, to prevent its shaking loose.

### THE NORWEGIAN HARROW.

This implement is becoming a great favourite with agriculturists, and deservedly so, for it far surpasses the ordinary harrows (of whatever kind) in performing several important

Fig. 14.



operations: first, for harrowing immediately after ploughing, it breaks and pulverises the furrow, leaving 3 or 4 inches' depth of fine mould beautifully prepared for seed; it saves the use of heavy and middle-sized ordinary harrows, the small seed harrows once over after sowing being sufficient. Secondly, while other pulverisers consolidate the land, and harrows leave the clay in large lumps, this implement pulverises, but does not consolidate. Thirdly, it prepares the roughest land, whether wet or dry, without clogging.

Fig. 14 represents this machine, as manufactured by Crosskill, of Beverley. It has three sets of rowels, 4 feet 6 inches wide, placed upon round axles.

An improved method of regulating has also been adopted, to adjust the true incline of the harrow spikelets or rowels, which very much reduces the draught.

Making the points longer, oval-shaped, and thinner, has been found to materially improve this implement, as it enables them to cut, and get more hold of tough and hard soil, as well as to work the land deeper.

## CULTIVATORS.

Under this head may be placed a large class of implements, bearing a variety of names, as drags, scarifiers, grubbers, scufflers, pulverisers, &c., &c., but whose objects all tend to the same purpose, that is the producing a fine tilth to the soil, tearing up the surface, and eradicating the weeds and rubbish. Harrows might very properly be placed in the same category, as the object of their use is precisely the same, the difference being only in the size and effectiveness of the machine; harrows being fitted with a large number of small teeth, and acting comparatively on the surface, while the implements we have placed under the head of cultivators have a few teeth, but of much greater strength and size, consequently their operations extend to a greater depth into the ground, and a variety of operations are performed by their aid that could not be accomplished by harrows; indeed, so strong and effective are some of the larger kind, that they are used in some cases instead of ploughs; and stubbles, &c., are often broken up, and the land re-sown, without the plough being used.

Although the use of such implements is of a modern date, yet cultivators have been in use in some shape or other for a considerable period. I find, in a book published more than fifty years since, several descriptions of instruments bearing characteristics much like those now in use, and high eulogiums passed upon their use. One of them

much resembles the implement lately introduced as Johnson's Cultivator, and which will be found described at page 66. It is called a broad-share skim, and used for the purpose of cleaning stubbles, particularly beans, peas, &c., to prepare them for spring crops.

"In the Isle of Thanet these are made straight and sharp, very strong, 4 feet in length, and are often hung behind a pair of cart-wheels. Elsewhere they are made in the form of a crescent, or of a large prong with three or four large flat tines drawn horizontally, with the points forward, which force their way among the flints and loose stones." *Hayward's Extirpator* is also described as a most powerful implement, and a plate of it is given in Young's "Suffolk." The tines and shares are fixed in an oblong wooden frame. The shares 8 inches broad and 9 inches long, fixed to stalks rising 10 inches, the distance between them being 11 inches, the hind ledge 6 feet long and 4 inches square, the fore-ledge 5½ feet long and 4 inches square, the ledges 12 inches apart, the beam 7 feet long, its elevation 3 feet 3 inches. It was fitted with two handles, and fixed to the wheels of a common plough, and made to go shallow or deep in the same manner.

This implement is much like one introduced many years later by Fuller of Ipswich, with the difference that Fuller's had but one row of tines, and the ledges which carried them were supported on wheels; but this latter implement was quickly superseded by an ingenious machine, called Finlayson's patent Self-cleaning Harrow, a well-known implement, upon the principle of which a variety of similar machines have been constructed of modified forms. Among these Wilkie's Parallel Adjusting Brake may be mentioned, as having some important improvements, yet constructed upon precisely the same plan.

### KIRKWOOD'S GRUBBER

Was also of a similar character, but had the important addition of handles, which gave the operator power to regulate the depth to the greatest nicety, and when it became chocked to throw it out of work.

### BIDDELL'S SCARIFIER

Approaches more nearly to this class of implements as now constructed. It consists of a double row of tines of great strength, fixed in an iron frame which is supported by two wheels about 4 feet in height; the teeth are so arranged that those in the hinder row shall work in a track midway between that of the front ones; the fore-end of the machine is supported on two smaller wheels attached to an upright shaft, the machine thus being suspended upon three pivots; and by means of two ingeniously arranged levers the two rows of tines may be made to work in any manner that may be required. It is altogether a most admirable machine, and capable of executing a large amount of work in a short time, and under difficult circumstances; but it has now given way to another, of a somewhat different character, called

### LORD DUCIE'S CULTIVATOR, OR THE DUCIE DRAG.

This implement is now very generally used, and is manufactured by most machinists, and although its actual form and manner of getting up may vary occasionally, according to the ingenuity or fancy of the maker, its principles always remain the same. The Ducie Drag, or

*The Uley Cultivator*, as it is often called, rests upon four wheels, the front ones being 1 foot 6 inches, and the hind ones 3 feet 4 inches in diameter. It is constructed of iron, of a strong and compact form.

The teeth are not placed in rows, but are arranged 2 feet apart, while the difference of the working track is only 6 inches. It is raised out of the ground, and the depth of working regulated with the greatest ease, by turning a handle upon which a worm is fixed, working into a wheel fixed on the cranked axle. This efficient implement is manufactured by Barrett and Exall, of Reading, of an improved form. The tines are so curved as to assist the action, by causing the rubbish to be deposited upon the top of the land; the points and shares are made to fit on without being pinned. An excellent variety of this implement was made by Stratton, of Bristol, with the application of his hollow iron bar. Having had considerable experience with this particular form of drag, I can confidently recommend it for the many purposes to which such implements are put.

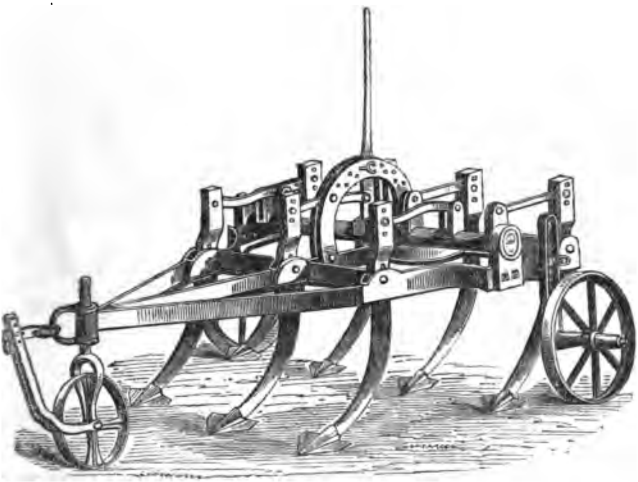
## COLMAN'S DRAG HARROW CULTIVATOR, OR SCARIFIER.

This is an excellent implement, invented by Colman, of Chelmsford, and manufactured by Garrett and others.

It is constructed upon a novel principle, and is well adapted for harrowing, paring, and cultivating land. There are seven prongs or tines, to which shares or spuds, varying from 2 to 10 inches wide, may be affixed. These prongs are arranged so as to cut the land 8 inches apart; the depth of penetration being regulated by a lever which acts upon a frame suspended about 6 inches above the lower one, and by an easy movement backwards or forwards regulates the depth of the tines or shares to the greatest nicety. It is a most efficient implement for opening and pulverising the soil; as shares of different forms may be placed upon the tines, it may easily be applied to other purposes, as a skim-parer, &c. Messrs. Garrett have added an improvement, by which one side may be depressed lower than the other, to

adapt it better for working on sloping ground, and so simply that it can be altered while in use.

Fig. 15.



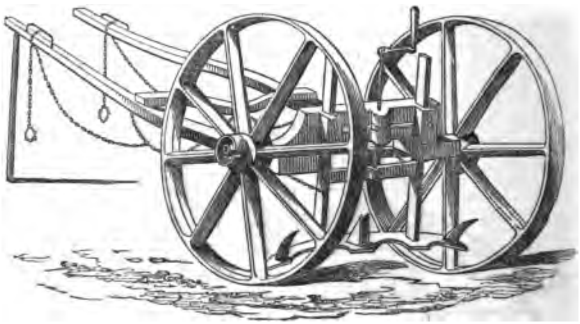
A smaller implement, called a subsoil harrow, is also manufactured by Colman, for stirring the subsoil; it has two tines, united by the framework above, and a connecting-bar at the bottom, upon the end of which is placed a kind of share, the depth being regulated by a lever similar to the large drag.

### JOHNSON'S SKIM CULTIVATOR.

This is the invention of the Rev. E. H. Johnson, of Grovelye, Linfield, Sussex, and is manufactured by Messrs. Garrett. It is for the purpose of breaking up and pulverising land, clearing it of weeds, rubbish, and of couch grass, and it is asserted, at a less expense than by the means usually resorted to. It is said that a lad with three horses may go over five acres per day; and as the implement, from its simple form,

is not so likely to choke up as most similar implements are, or require to be taken out of the ground so often, it is quite possible this may be the case. It is found greatly to facili-

Fig. 16.



tate the working of land during, and immediately after, harvest, for the purpose of bringing it into a proper state of tilth for the early root-crops in the spring of the year, and also for cleaning bean and pea stubbles, tare lands, &c., in preparation for coleworts, mustard, rape, and turnips, for early autumn feeding, and leave the land in a good state for the wheat crop.

## ROLLERS.

The operation of rolling land is to effect several different objects, the principal of which are, the breaking the large lumps of earth that have been sun-dried, and to assist in the preparation of a finer tilth, or pressing in the ground about newly-sown seed, and to compress and smooth the surface of grass land, and render it better adapted for mowing. The roller is a modern implement, as it would not be required in the cultivation of such lands as were cropped in earlier times.

Rollers are made of wood, stone, and iron. The old implement was a rude affair, constructed on the farm with the best materials that could be had. Stone was introduced as being more effective from its greater weight, but could not be made of the same width, and therefore was more inconvenient. Iron is now the material generally employed, and it is by far the best.

An immense number of differently designed rollers have been introduced—one of the earliest was by Mr. Booth, of Allerton, near Liverpool, and is described by Mr. Ransome as consisting of five cylinders of small diameters, pressed into the ground by levers with weights attached. The inventor considered that rollers with small diameters would act much more effectively than those that were larger; this, however, was an erroneous opinion, as the advantage gained by its acting on a smaller space was more than counterbalanced by the difficulty of getting it to travel over rough land.

The modern iron roller is a very effective implement. It is generally constructed of two or more separate cylinders of various diameters, the axis of each being independent of the other—thus enabling it to turn with facility, and without injuring the crops, whether grass or grain. One, made 6 feet 6 inches long, and 20 inches diameter, weighs about 9 cwt. The barley-roller consists of two cylinders, one a little in advance of the other, but in a parallel line. The two inner ends cross an inch, so as to leave no land unrolled, and being jointed by a hook and eye rather loosely, the roller adapts itself to an uneven surface. Each roller is 5 feet long and 10 inches diameter.

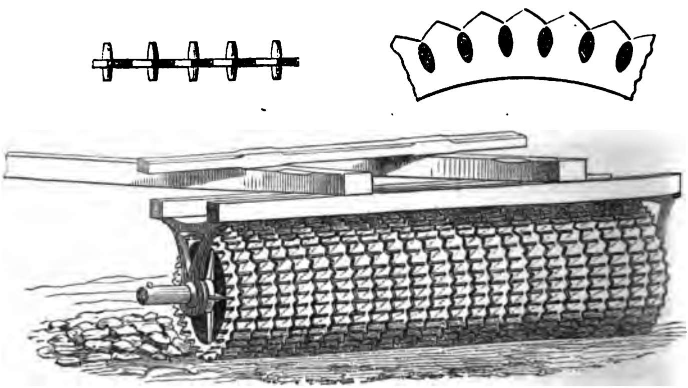
*The Northumbrian Roller* consists of two series of iron rings, or discs, running loosely on axles; the wheels, or discs, of one row locking into the other row in front, each disc of the hinder row thus running between two on the first row. The edges being sharp, similar to Cambridge's

roller, it acts well as a clod-crusher. It is manufactured by Gibson and Son, of Newcastle. Wheels of larger diameter are attached to gudgeons, fixed at either end of the machine, to facilitate its removal from place to place, similar to those described as attached to the Crosskill clod-crusher.

## CROSSKILL'S CLOD-CRUSHER.

Of all the modern implements introduced, this may be pronounced the most valuable and most generally appreciated, and the most useful for effecting a variety of different mechanical operations, and in giving a fine tilth to the soil.

Fig. 17.



Crosskill's roller, as now manufactured, is the result of great experience in its use, a variety of improvements having been made in it since it was first patented. It has always been brought to compete with rollers of similar character, and always carried away the prize—no other implement of its kind ever having stood the least chance when in competition with it.

This implement is successfully applied to effect the three different purposes for which the spike-roller, the Norwegian, and the wheel-roller are employed, and effects the object better than these three combined. The advantages gained by the use of this implement are—first, the lessening the expenses of tillage by mechanical aid, in crushing the hardest clods, and pulverising the roughest fallow land; secondly, in compressing light and puffy soil to grow therefrom stronger and more productive plants; thirdly, in rolling cultivated land, and preventing the ravages of the wire-worm and grub, thereby increasing the quantity and improving the quality of the corn. The machine consists of a series of cast-metal rings, or roller-parts, placed loosely upon a round axle, and revolving thereon independently of each other, thereby producing a self-cleaning action, and by which the machine is turned round about on fields of growing corn without tearing up the soil, destroying the plants, or half burying itself in a hole while turning, as many similar implements do. The surfaces of the roller-parts are pointed with serrated edges and a series of inner teeth, projecting sideways, fixed at a particular angle to the centre of the roller-axle, so as to act most effectually in penetrating clods perpendicularly, and in consolidating the young plants in the soil. The discs on this roller (as originally constructed) were fast upon the axle, but they are now made to revolve independently of each other, an advantage which not only increases its efficiency, but materially lessens the power required for its draught. Another improvement has also been made in making the eye larger in the hold, so that when revolving separately upon the round axle, they cause an irregular velocity by the rims perpetually varying, and effecting an eccentric, or up and down, action along the whole of the roller parts, thereby increasing its power, and giving it the best means for self-cleaning itself in working.

As this roller could not be removed from place to place as

an ordinary one, two travelling wheels are added of larger diameter, so as to lift the roller-parts clear off the ground. When the roller has arrived in the field where it is intended to be used, a hole has to be dug under each of these travelling wheels deep enough to let the roller-part down upon the ground. The same operation has to be repeated when the wheels are to be again placed upon the shaft.

This machine is now manufactured of a variety of sizes, adapted to the various kinds of plants and systems of husbandry. The following are some of the advantages and effects produced by the use of this machine, and a few of the purposes to which it may be applied:—For crushing the hardest clods in the driest seasons upon the strongest fallow lands, the deep indented edge-points of this ponderous machine penetrate and abrade the roughest clods, reducing big masses of clay and baked soil into a fine mould, where, in many cases, from the nature of the soil, and the inefficiency of other implements, it would be difficult, or even impossible, to prepare the land without the serrated clod-crusher. It insures the certainty of a sowing season in the driest weather, and rapidly converts many acres of heavy land into the finest condition for the reception of grain or the smallest seeds, and leaves the soil then equal to once harrowing. Spike rollers and Norwegian harrows will not effect this, as they drive the large sun-dried clods before them, or pass harmlessly over the surface. It is also valuable on strong land farms to prepare the ground before drilling, and again rolling over it as soon as sown. Upon lands sown in autumn, which are cloddy in the spring, it reduces these, and gives a fine surface-mould, while it prepares the soil around the roots of the young plants, without in the slightest degree injuring them. Upon light soils it is preferred to the action of seam-pressers, as it effects the desired degree of tenacity and solidity without leaving a smooth surface, and entirely prevents the land from scarping, which frequently occurs after using a plain roller.

The practice of driving sheep over corn-lands to give firmness to or fasten the soil, is rendered unnecessary by using this machine, as the action of the tread of the sheep is well imitated by it, and it effects the object in a more equal manner. The serrated teeth (when the land is very light) go down to the roots, and firmly secure the young plants in the soil, leaving little hillocks, or a harrowed-like surface which affords a beautiful protection against cutting winds and intense frost.

Oats, wheat, and barley may be rolled and much improved at a cost of 2*s.* per acre. The action of this roller has been well compared to the act of a gardener pressing the mould with his fingers round the young plants, while the common smooth roller more resembles the act of putting one's foot upon the plant, which would be likely to destroy it.

It is also used for preparing land to sow clover, beet, &c. It makes the finest bed for the reception of the smallest fine seeds.

For staying the ravages of the wireworm, this implement is of the greatest possible advantage. I have myself used it for the purpose with the greatest success. I have rolled one part of a field that was full of wireworm, and left the other. The half rolled carried a good crop, while that which had been left to itself was utterly destroyed.

In the *Royal Agricultural Society's Journal*, vol. IV., part ii., pp. 560 to 580, will be found a report upon all these various advantages said to be obtained from the use of this roller, and the replies of an immense number of leading agriculturists to the following queries:—

1. How far valuable for crushing clods, and breaking up the strongest fallows in the driest seasons?
2. How far valuable upon strong lands, for rolling corn as soon as sown, and lands sown late in the year, which are cloddy in the spring?

3. How far valuable upon light lands, for rolling corn as soon as sown, and in the spring, after frost?
4. How far valuable in stopping the ravages of the wire-worm and grub?
5. How far valuable upon grass lands, upon mossy lands, and worm in meadow lands?

To all these queries the most satisfactory answers were given, showing that for all the different objects enumerated in the queries, this machine was specially valuable, and in none more so than in stopping the ravages of the wireworm.

An immense number of these replies are printed in the journal alluded to, and many contain valuable remarks and hints well worth attentive perusal.

Some people have adopted the plan of rolling between the rows of potatoes, beans, &c. (growing crops); it is said to do what could not otherwise be effected, that is, leaving a crushed, pressed, and harrowed-like surface between the rows, even when the potatoes are grown several inches. The 6 feet size of roller is best adapted for this purpose, as it will roll three rows at a time. The horse walks in a line up the centre row, and the iron discs being removed from the axle where the lines of plants occur, and in their places iron bushes placed, so dividing the great roller into three smaller ones.

A serrated roller of a much lighter description has been constructed for fen lands.

It has been remarked that the roller requires much judgment in choosing the fitting time to use it, and this observation applies more especially to the one we have been describing.

### CAMBRIDGE'S PRESS WHEEL ROLLER.

This also is a clod-crusher of an efficient character. It is composed of a number of wheels or discs of iron placed side by side, with thin cutting edges. It is considered a useful implement, and acts well in crushing clods and preventing the ravages of wireworms and slugs, and in rolling pastures.

A great variety of other rollers are manufactured, and called by a variety of distinguishing names, as drill rollers, seam or land pressers, &c., the peculiarities of which we have not space in this little book to describe.

### THE HORSE-HOE.

To Jethro Tull (the introducer of the drill system of husbandry into England) we are indebted for this most valuable implement, he being its original inventor; for, as Mr. Ransome remarks (in his "Implements of Husbandry"), "previous to his time we search in vain for the slightest allusion to such an instrument in the works of any writer upon agricultural subjects."

Tull laid the foundation of the present advanced state of agricultural science, in the adoption of what he called horse-hoeing husbandry; indeed, so much was he in advance of his time, that it is only now that his works are being properly studied and understood; for although, like most enthusiasts, he carried his principles too far, yet in the main he was right, and the drill and horse-hoe are the two implements upon which depend much of the farmer's success in the cultivating crops with profit.

The horse-hoe possesses immense advantages over hand-hoeing, principally in the rapidity of the operation, and in the economy of labour; for, as Mr. Blackie remarks,

"expedition is a most material point in all processes of husbandry carried on in a variable and uncertain climate; and it frequently happens that hoeing in any way can only be executed to advantage in a very few days in the spring; hence the horse-hoe has a most decided advantage over the hand-hoe, for a man will only hoe about half-an-acre a day with the latter, while with the former a man and a boy, with one horse, will hoe eight or ten acres a day, and that in a more effectual manner."

Tull's horse-hoe, as he originally contrived it, is represented in his book. It is a rude implement, somewhat resembling a roughly-shaped swing-plough, without a mould-board, and having the cutting edge of the share turned up on the land side.

Subsequent horse-hoes, while less rude and more ingeniously contrived, were all of a simple character, and generally resembled swing ploughs fitted with hoes, or were a description of implement more resembling modern grubbers or scufflers. One of these bore the name of the Kentish nidget, or tormentor, and is described as a horse-hoe with triangular shares fixed horizontally at the extremities of tines, which are driven into a three-cornered wooden frame in cross-bars. At the corner by which the implement is drawn, a wheel is fixed, in order to give the coulters their proper depth. The shim or broad-share was another description of implement of the horse-hoe character, as was also an implement called Hayward's extirpator.

A hoe was invented by the elder Wilkie, of Teddingstone, about the year 1818, and considered a very efficient implement. Three coulters were attached to the body and wings of the beam of a plough; a small harrow followed, and a wheel was placed at the end of the beam to regulate the depth, and facilitate the turning it and clearing it of weeds.

A horse-hoe with parallel motion was invented by the

younger Wilkie, which admitted of easy expansion and contraction, to suit the different widths of drills.

Weir's expanding horse-hoe was of a similar character, and might be worked either as a hoe or as a double mould-board plough.

Besides these, others were constructed by Morton, of Edinburgh, Hawick, Brodie, Henry, and others.

*Blakie's Horse-hoe.*—This was the first implement that was successfully employed in hoeing between several rows of turnips at once; it was the invention of Mr. Blakie (author of a treatise on farm-yard manure), and was made by him while manager of the estates of the Earl of Leicester, and is the foundation of many of the most approved horse-hoes now in use.

*Grant's Horse-hoe* is a well-arranged implement, and an addition was afterwards made to it, by which all the hoes could be instantly raised, should they become choked with weeds or rubbish.

An immense variety of every description of horse-hoes are now to be met with at Agricultural Societies' meetings, and the farmer may there choose such as he considers best adapted to his land or peculiar manner of cultivation.

Among these the horse-hoes of Messrs. Garrett of Leiston, Mr. Smith of Kettering, Mr. Howard of Bedford, and Mr. Hensman, are conspicuous for possessing all the requisite qualities that should be met with in this description of implement. As nearly all the makers of agricultural machines manufacture horse-hoes of an approved character, it will be impossible to notice more than one or two of those whose improvements have brought them more prominently before the public than others, and foremost of these is—

## GARRETT'S HORSE-HOE.

This is one of the most efficient implements of its kind, the greatest possible care having been taken by the Messrs.

Garrett to add to it every improvement that practice or theory shall have pointed out, to render it more perfect, and nearly everything that can possibly be required of such an instrument may be found in this machine. It has had prizes awarded to it at Liverpool, Bristol, Derby, Southampton, Northampton, York, Norwich, Exeter, and at the Great Exhibition, a Council medal.

Corn or roots of every kind, drilled in rows of not less than seven inches apart, may be hoed in a perfect manner, and at a cost, it is said, of about 6*d.* an acre.

"This implement," says the report of it in the *Journal of the Royal Agricultural Society*, "is so complete in itself, as to be fully suited to all methods of cultivation, whether broad, stitch, or ridge ploughing; and is adapted for hoeing corn of all sorts as well as roots. The peculiar advantages of this implement are as follow: it may be increased or diminished in size, to suit all lands or methods of planting; the axletree being moveable at both ends, either wheel may be expanded or contracted, so as always to be kept between the rows of the plants. The shafts are readily altered, and put to any part of the frame, so that the horses may either walk in the furrow, or in any direction to avoid injury to the crop. Each hoe works in a lever, independent of the others, so that no part of the surface to be cut, however uneven, can escape; and, in order to accommodate this implement for the consolidated earth of the wheat crop, and also the more loosened top of spring corn, roots, &c., the hoes are pressed in by different weights being hung upon each lever, and adjusted by keys or chains, to prevent them going beyond the proper depth. What has hitherto been an insuperable objection to the general use of the horse-hoe is over-ruled in this by the novel and easy method of steering, so that the hoes may be guided to the greatest nicety, if common caution be used, doing every execution among the weeds, without injury to the crop. This implement is so constructed, that the hoes may

be set to any width, from seven inches to any wider space. For the purpose of hoeing all kinds of corn, the inverted hoes only are preferred; but for the root crops, where the rows of plants are wider (say 16 inches or more), an extra hoe, of a semicircular form, is placed on a separate lever, working between and in advance of the two inverted hoes, for the more effectually cutting all the land, however uneven the surface, by the three separate hoes working independently of each other between the rows. The hoes are of peculiar improved manufacture, the blades being of steel, and made separate, and attached to a socket handle, in a simple and easy, yet effectual manner, so that any husbandman may replace them; and being manufactured by the patentees at an exceedingly low price, no difficulty can arise in replacing those parts subject to wear. In order to set the hoes in a proper cutting position, for either flat or stitch ploughing, and so as thoroughly to cut either hard or soft ground, the levers are put into a more or less oblique position, causing the cutting edges of the hoes to be more or less inclining downwards, by raising or lowering the jointed irons to which the forward ends of the levers are suspended and swung; which is done by merely moving the pin which rests upon the frame into different holes."

## SMITH'S STEERAGE HORSE-HOE

Is one of the very best implements of the kind that I know of, and one that I should much recommend to small farmers as a cheap and truly efficient implement. It may be adapted to a variety of purposes, and the cost for one completely fitted up varies from *5l.* to *7l.* only.

It is so complete in itself, that it is fully suited to all sorts of drilled crops, either flat or ridged, and is adapted for hoeing wheat, barley, peas, beans, mangold-wurtzel, or turnips, at any given width that may be required.

The axletrees are made moveable at both ends, so that either wheel may be set further out, or closer in, thus adapting itself to keep between the rows of plants, and suit itself to all lands and methods of planting.

The person operating with this implement has the power of guiding it between the rows with the greatest nicety, and while thoroughly hoeing and tearing up the weeds, preventing the slightest injury being done to the plants, the steerage being quite independent of the horse, and so simple that any one may control it with the greatest ease.

The working depth of the hoes is regulated by placing the levers in a more or less oblique direction, which is done by merely moving the pin which goes through the shaft-iron into different holes, thus inclining the hoes more or less downwards, and better suiting it to cut either hard or soft ground. The width of the hoes is regulated by loosening the screws of the clip which fastens them upon the wrought iron bar or bars upon which they are placed. The two outside hoes may be placed parallel with the wheels, so as to cut the ground which they run upon. A seed drill can be attached, for sowing small seeds, and driven by a pulley on one of the wheels.

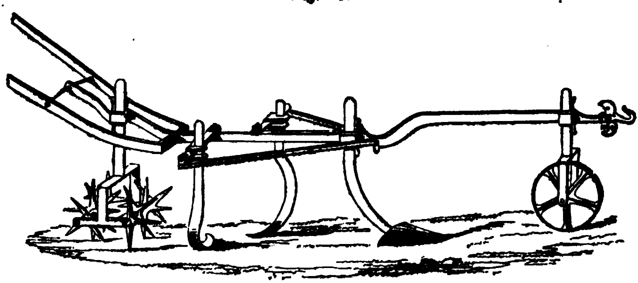
## HOWARD'S HORSE-HOE

Is made entirely of wrought iron, and intended for one row of beans, peas, turnips, &c. It has three shares, which are made to slide upon the frame, so as to take the various widths required; it has two wheels fitted to a swing head, working upon a centre bolt, and the draught being central, the implement is not affected by any irregular motion of the horses. This arrangement, also, causes the implement to work much steadier.

HILL'S HORSE-HOE.

This is an expanding horse-hoe, invented by Edward Hill, of Brierly, near Dudley. It is intended for one row of turnips, beans, potatoes, &c., and has three shares, which can be expanded or constructed to the desired width by pressure upon the handles only, and which can be performed whilst the hoe is at work, with the greatest certainty as to distance. A small Norwegian harrow works behind the hoes, which not only has the effect of steadying the implement when at work, but which is also very effective in bringing weeds, &c., to the surface, and thus saving repeated hoeing, caused by weeds growing again when not brought effectually to the surface. The improvement consists in the slides of the hoe, upon which the wings work or expand, being placed upon, and in fact forming part of the wings, and sliding through the centre bar of the implement, so that these slides cannot project beyond the cutting parts of the implement. The above description is copied from the catalogue of the implement exhibited at the Lewes meeting of the Royal Agricultural Society.

Fig. 18.



BUSBY'S HORSE-HOE.

Fig. 18 represents a most excellent implement of this

class, and one that has gained several prizes. It is shown so clearly in the wood-cut as not to require any further description. A portion of the stilts or handles have been removed to get it on the page.

## CHAPTER IV.

### MANURE DISTRIBUTORS.

A VARIETY of machines have been constructed for the purpose of distributing manure, both liquid and in a solid state.

For crops that are drilled, the best plan is to deposit the manure with the seed, as described in the chapter on drills; but as all crops are not drilled, and it is of importance to sow some manure broad-cast, ingenious contrivances have been made for effecting that purpose.

For the distribution of liquid manure, no system can equal the laying down mains (as practised by Mr. Huxtable, Mr. Mechi, and other gentlemen), and forcing the liquid through the pipes by force-pumps, worked by the steam-engine of the farm or some other motive power. Doubtless this may be very expensive in the first outlay, but I am satisfied it is the true plan, and will turn out the most economical in the end. When the practice of using manure liquid is better understood, and a hundred times the quantity used, which will be the case when the facilities (before alluded to) exist for distributing it, then not only will the liquid manure drained from the stalls and yards be sent to the land in a diluted state, but liquid manure will be manufactured by dissolving guano, and other concentrated manures, in water—carrying them to the land in this state instead of the ordinary plan of sowing—by which a very

large portion, the most valuable ingredients of the article, is lost. This fact is generally rendered pretty evident by the strong smell existing in the fields surrounding the one on which guano is being sown broad-cast. Drilling is doubtless a much more economical method, but this has its disadvantages, and cannot always be done.

Carts for distributing liquid manure are made by most agricultural implement-manufacturers of an efficient character, and at a moderate price. They are often fitted with pumps as part of the machine, and the best are made entirely of iron. An excellent specimen is made by Mr. Crosskill. The body of the cart is made entirely of iron plates, securely cemented and bolted together, and will contain about 100 gallons. It is fitted with a brass outlet valve, acted upon by an iron level rod, with which the driver opens and closes the valve, while walking by the side of the horse. The newly invented pendulum-spreading apparatus is attached, which regulates a sliding front adapted to water equally upon uneven land, six feet broad-cast; also, an improved apparatus for watering four rows of turnips at a time, by the use of four flexible tubes, guided by two lads with handles. By this means dissolved bones, and diluted sulphuric acid, or guano water, may be applied to water the ridges or rows any required width; an addition may be also made of one or two partitions inside across the cart-body to prevent the surging of the liquid upon uneven or bad roads. The objection to Crosskill's former cart was its not watering equally upon uneven lands, as when it passed over a slope or inclined surface the liquid naturally flowed to the lowest end of the fixed spreading board. By the improved method, the cart will water equally well whether the land be uneven or not. The apparatus being suspended to a pivot, with a regulating guide, it is fitted with pump and hose, and costs about 15*l*. It is an exceedingly complete thing, and one that can be recommended with safety.

Messrs. Deane, Dray, & Co., sell a manure tumbler cart, which is much approved of. It has a wrought iron body and is suspended between two wheels of 4 feet 6 inches diameter insuch a manner as to be filled and unloaded with great facility.

A very good liquid manure cart may be made by placing a barrel between a pair of Indian wheels. A tap at the back discharges the liquid into a trough placed cup-ways, and bored full of holes.

## BLYTH'S BROAD-CAST MANURE DISTRIBUTOR.

This implement has been but recently introduced. It is manufactured by Garrett's, of Leiston, and gained a prize at Lewes. It is for the purpose of distributing regularly all kinds of natural and artificial manures, and the novelty consists in the arrangement of the machinery for the perfect delivery of those most difficult to distribute.

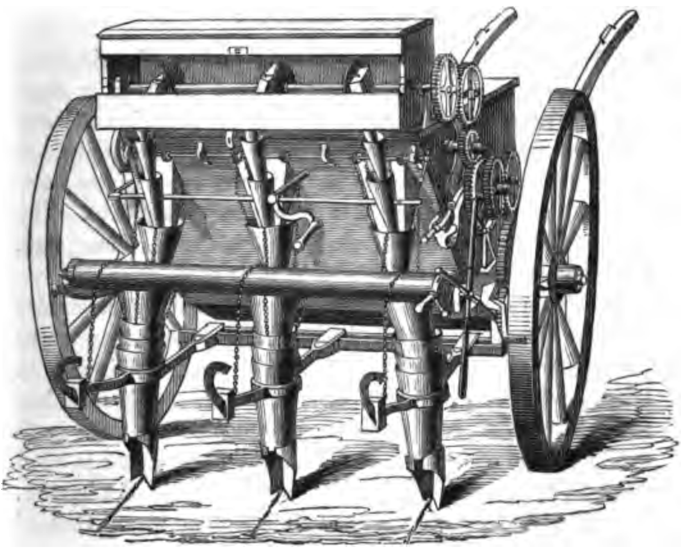
The manure is delivered from the box by means of a barrel, consisting of a shaft fitted with prongs, which carry over the manure, and, in doing so, it comes in contact with a series of scrapers, which rise with, and clean the barrel as it rotates the manure; then passing down the shoots, or conductors, it is evenly distributed all over the surface, or in rows, as may be required. The shoots, or conductors, are furnished with wire rods, fixed in alternate lines, giving them the effect of a sieve, whereby the manure is separated and pulverised as it falls.

*Chandler's Manure Distributor* is represented in fig. 19. It is an excellent invention, and consists of three sets of buckets, working on an endless chain similar to chain pumps and dredging engines. The cistern will contain two and a half hogsheads, and will distribute from the smallest quantity to 40 hogsheads per acre. It has obtained several prizes, and is much in request. Straw, leaves, and other

Fig. 19.

CHANDLER'S MANURE DISTRIBUTOR.

Fig. 20.



CHANDLER'S PATENT LIQUID MANURE DRILL.

matter that clogs most machines of this class, are, in this case, carried over with great facility.

CHANDLER'S PATENT LIQUID MANURE DRILL

Is on the same principle, and also much approved of. This machine will drill liquid with seed in any state of fluidity, and any quantity, from 3 to 10 hogsheads per acre; it will also distribute liquid manure broad-cast for top-dressings. It is the invention of Thomas Chandler, Esq., Aldburn, improved and manufactured by Thomas James Reeves, of Bratton, near Westbury, Wilts.

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## CHAPTER V.

### SOWING MACHINES

Chiefly consist of drills. In the early history of agriculture sowing was all done broad-cast; indeed no other method would have suited the cultivation of the description of lands first sown with corn. Machines for the regular distribution of corn, or corn and special manures, have nevertheless been invented and used in the East from a very early date. The farmers of India, Japan, and Arabia have, from time immemorial, drilled and dibbled in their seeds.

The Chinese sowing machine of the present day resembles in some respects a hand barrow, and in others a small plough, and has three hollow teeth of about 28 inches in length, with iron supports, and carries the seeds in a box above the wheels, and drops them thence through the teeth to the ground in rows. It follows the plough, and is itself followed by a roller, which answers the purpose of a harrow. The Hindoos deposit the seed in a similar way. Gabriel

Platte describes a rude dibbling machine formed of iron pins, "made to play up and down like virginal jacks;" and about twenty years later, 1669, John Worlidge, in his "Husbandry," not only advocated the use of a seed-drill, but a manure-drill also. Evelyn strongly recommended the Sembrador drill-plough to Englishmen. This was the invention of a Spaniard, Don Joseph de Lescatello. It was fastened to the tail of a plough, and dropped the seed regularly in the furrow, and is said to have effected the sowing of a given area with a saving of about one-fifth of the seed usually deposited by broad-cast sowing. Some writers state that this machine was invented in Germany and carried from thence into Spain. It was in the latter country, however, that it attracted the notice of the Earl of Sandwich, the English ambassador, and he forwarded it to this country as a Spanish invention; but it seems to have been looked upon merely as an agricultural curiosity, and no regular use seems to have been made of it until Jethro Tull, in 1730, devoted all his abilities and energies to bring it into use, to more readily perfect and introduce his great idea, horse-hoeing husbandry. Tull, delighted with the advantage gained by the use of the two instruments, soon set about improving the sowing machine. His first invention was a kind of plough, with drill attached, for sowing wheat and turnips in three rows at a time; it consisted of two seed-boxes with a coulter attached to each, and following each other; behind them followed a harrow to cover in the seed. His object in having two separate deposits of seed, and at different depths, was that they might not sprout at the same time, and so perhaps escape the ravages of the fly. Tull also invented a turnip-drill, and in the cultivation of turnips his practice was more applicable than to wheat, for he was deceived by theoretic notions in reference to the capability of the soil to supply the food of the plants, and instead of carrying out an efficient system of drilling and hoeing, he

attempted to grow corn year after year on the same soil without manuring. His turnip-drill was similar to the other, but lighter. The feeding spout was so arranged as to carry one-half backwards after the earth had fallen into the channel; a harrow was pinned to the beam, and by this arrangement one-half of the seed sprung up sooner than the other, and so escaped the ravages of the turnip-fly. Tull adopted here for the first time the plan of having cavities formed in solid cylinders for the purpose of feeding.

Nothing more seems to have been done towards drill improvements until about forty years afterwards, when Sir James Anstruther introduced to the Bath and West of England Society one of his own invention, and which he had previously used for about eight years without its getting at all deranged. It was a double drill-plough, constructed for sowing two furrows at once, the horse walking between, that the soil might not be injured by the tread of the horse's feet.

During the next dozen years as many patents were taken out, two of which were for effecting the double operation of depositing both seed and manure at the same time; yet none of these came much into use until James Cooke, a clergyman of Heaton Norris, in Lancashire, invented the drill, upon which is founded all the machines now in use, for its principles are adopted, more or less, in every one of them. In Mr. Ransome's book is a cut of this drill, and the following description:—

"The seed-box is of a peculiar shape, the hinder part extending lower than the fore part. It is divided by partitions, and supported by adjustable bearings, so as to preserve a regular delivery of the seed, whilst the machine is passing over uneven ground. The feeding cylinder is made to revolve by a toothed wheel, which is fixed on each end of the main axle, and gears with other toothed wheels on each end of the cylinder; the surface of the cylinder is

furnished with a series of cups, which revolve with it, and are of various sizes, according to the different seeds intended to be sown. These deposit the seed regularly in funnels, the lower ends of which lead immediately behind the coulters, which are connected by a beam so as to be kept in an even line, and are capable of being held out of working when desired by a hook and link in the centre. The seed, as it is deposited, is covered in by a harrow fixed on behind. The carriage wheels are larger than usual, by which means the machine is more easily drawn over uneven ground, and the labour of working is reduced."

About the year 1790, Cooke's drill having found its way into Norfolk, fell into the hands of Henry Baldwin, a farmer living near Harleston, who, aided by a local workman named Samuel Wells, contrived several ingenious improvements to the machine, the first of which was in making a sliding axle-tree, by which the carriage-wheel could be extended when necessary to the width of the stitches, and so enable another box with cups and more coulters to be used. A drill containing fourteen coulters could be thus enlarged to contain eighteen, or even twenty.

He also constructed self-regulating levers, to which the coulters were attached; by hanging each coulter on a separate lever, each lever swinging by an ordinary hinge joint, and having a movable weight at the outer end to press the coulter into the soil to the required depth.

These two improvements are both in use at this day, and must have at the time very much advanced the reputation of the implement for efficiency and ability to work on land having an irregular surface, as the levers hanging independently of each other were able to adjust themselves to any irregularities they might meet without disturbing the whole machine, as was the case with the original Cooke's drill.

From this time the patents for improvements in drills

have been very numerous, and the competition in their manufacture at the present time among some of the most eminent agricultural implement makers brings into the market an immense variety of machines adapted to every conceivable requirement that peculiarity of land, style of farming, or description of seed or manure to be deposited, may suggest.

Before proceeding further with the subject of drills, it may be better perhaps if I describe in the shortest manner possible the principle and arrangements of the parts of the ordinary drill as in general use; for though there are a variety of ingenious mechanical contrivances attached, peculiar to each, yet the general arrangement is the same, as is the object for which each one of its class is constructed. The ordinary drill consists of an oblong box, mounted in a peculiar manner upon a carriage with large wheels; this box is divided longitudinally with a partition, thus making two compartments, the inner one being called the seed box, and the outer one the delivery box. In the seed box is placed the grain intended to be sown, and in the partition between the two boxes are a series of openings called pigeon-holes, through which the seed is allowed to pass into the delivery box, the quantity being regulated by small slides, which will be more particularly described hereafter.

In the bottom of the delivery box are a series of holes (communicating with pipes or shoots below); in these holes are placed small tin hoppers which stand a considerable height above the bottom. From end to end of the delivery box there is placed a spindle or small shaft, and upon this wrought iron discs, as many as there are holes in the bottom of the box. Projecting from the side of the discs are a series of small stalks, having at their outer ends little cups, thus forming a number of little spoons. By an arrangement of wheel work, connected with the wheels of the carriage of the machine, those discs are made to revolve along with the

shaft upon which they are placed, and in doing this they take up from the bottom of the box the seed which has been admitted from the seed box, and as they pass round, drop it into the hoppers before mentioned, through which it passes into a pipe, to be conveyed to the ground, where a proper place has been prepared for it by another portion of the machine.

Attached to a portion of the fore part of the carriage, by hinges, are a series of lever bars, upon which are placed coulters, numbering as many as there are pipes descending from the delivery box; weights are placed upon the levers to press the coulters into the ground to the desired depth; and as the machine moves forward, each coulter opens a little furrow, into which the seed from the pipe is deposited. Such a drill as I have described would merely deposit seed, but now that so much valuable artificial manure is used, drills are constructed to sow manure along with the seed. When this is the case, another box for the manure is provided, and an additional set of pipes, coulters, and other apparatus. The first coulter then opens a rut, into which the manure passes from the pipes; a forked piece of iron follows, which covers a little of the mould over the manure; the next coulter follows, and after it the seed is deposited in the manner shown in the annexed diagram.

Fig. 21.

The bottom stratum is the manure; above that a thin layer of mould, to prevent the manure and seed coming in contact; upon that the seed to be sown, and over that again some more earth; the seed then being placed in the most eligible state to be brought to maturity.

The operation of drilling may thus, by the most approved machines, be considered almost perfect; but it was by no means in that state when we left it as improved by Baldwin.

From that point it was taken in hand by two brothers, James and Jonathan Smyth, of Peasenhall and of Swefling, in Suffolk, "who (as stated by Mr. Ransome, in his book), in manufacturing this implement, for upwards of 40 years, brought it by their unremitting attention and ingenuity to the highest state of perfection," and Smyth's drills are, at the present time, considered as among the very best in use.

The improvements of these gentlemen were very numerous, but among the most important may be considered their improvements in the form of the manure box, trundle plates, and delivery cups; a mode of adjusting the distances between the coulters; *a swing steerage*, by which means the coulters could be forced from right to left or left to right, so as to preserve the parallelism of the lines for sowing the seed; and also the very important addition of *the apparatus for sowing manure and corn* and small seeds at the same time. Besides these, they also introduced some important improvements in driving the barrels, and adjusting the coulters, by means of the fluted roller and chain gearing now in common use.

Following upon these improvements of the Smyths, Messrs. Garrett have considerably improved this machine, by making the ends of the machine of iron instead of wood, as well as some better arrangements for changing the speed-wheels, also the adding another wheel to the opposite end of the machine, which equalises the velocity of the delivery cups, in ascending and descending hills, one wheel being used for going up, and the other for coming down; also a regulating screw, to raise and lower the box, and arrangement for extending or contracting the width of the drill.

Messrs. Hornsby have also much improved some of the details of their drills, by the introduction of some ingenious

contrivances: 1st. For regulating the position of the boxes while the machine is on sideling ground. This is done by means of a long screw, worked by a winch at one end, and secured by two bearings; two small arms, the upper ends of which are attached to the end of the box, and the lower ones work upon the screw, which, as it turns, brings the arms nearer together, or removes them farther apart, thus lowering or raising the box, as may be required, with the greatest nicety.

2ndly. A swing steerage, which allows of the coulters being maintained in a straight line with the greatest ease, and is worked by double handles attached to a toothed segment, and giving the operator great power over the machine.

3rdly. In a better arrangement for regulating the supply of seed from the seed box to the delivery box by means of a small shaft, having a cog-wheel placed at every aperture, or pigeon-hole. These act upon small racks in the manner of sluices, and regulate the supply with ease, certainty, and accuracy.

4thly. In the introduction of vulcanised India-rubber tubes, instead of a succession of conical tins, for conveying the seed from the delivery box to the ground. These tubes are said to be much superior to the tins when drilling in windy and rainy weather.

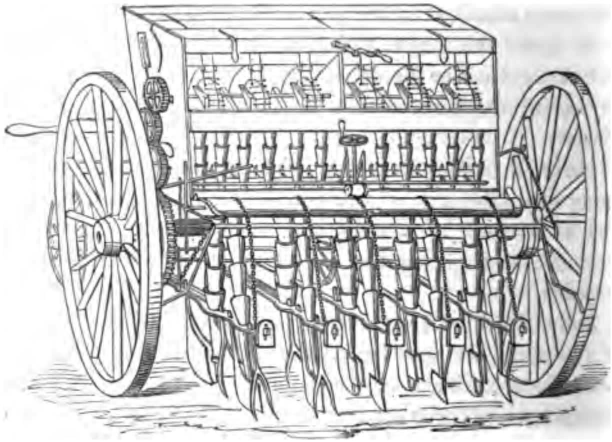
The use of flexible tubes is not new, as leather tubes have frequently been tried, but were found to wear out too rapidly. Mr. Hornsby's improvement consists in the application of vulcanised Indian-rubber for this purpose.

## GARRETT'S GENERAL-PURPOSE DRILL.

Fig. 22 represents the general-purpose drill of Messrs. Garrett, and it is considered one of the very best drills manufactured, Messrs. Garrett having bestowed great pains

in perfecting this implement by adding every improvement that practice could suggest for rendering it more effective.

Fig. 22.



It is adapted for performing all the various operations of seeding and manuring the land. All kinds of grain and seeds may be deposited at any required distances apart, and at any depth, either with or without compost or artificial manures.

They are constructed of various widths, and made to deposit the seed in rows from six to fifteen in number, and to suit all descriptions of land, whether ploughed flat or in ridges. The corn and manure are sometimes sown through the same delivery tubes, but it is better when double tubes and coulters are adopted, as the seed is then buried two or three inches deeper than the seed (as before described), and a portion of mould placed between the two. The boxes are suspended on a centre in the middle of the machine, and may be elevated or depressed, at either end, by means of a lever, so as to keep them at all times in a horizontal position,

and to insure a regular delivery of both on hilly as well as flat lands. This arrangement admits of the barrels, which deliver the manure and seeds, being driven by gear at the ends of the boxes in the usual way, thus avoiding all unnecessary complication.

Besides the general-purpose drill, Messrs. Garrett construct a great variety of this class of machines adapted to the various requirements of the agriculturists; and, although the general-purpose drill fully deserves its name, yet, when the farm is large, it is much better to have other machines made expressly for the purpose. Among these may be mentioned:—

*A Drill for Turnips and Manure on the Flat*, which deposits two or three or four rows of turnip or other seeds, with compost or artificial manures, on either flat or ridge ploughed lands. This machine is fitted with separate seed boxes for each row, placed on a horizontal bar, and may be shifted to suit the intervals between the drills, so as to come directly over the delivery spouts, and allow the conductors to work freely. The boxes are partitioned off into two compartments, one larger than the other, so that when drilling beet and turnip seeds together, sufficient of each to last an equal time may be put into the boxes at once. An apparatus is also provided for regulating the level of the seed and manure boxes.

*An economical Three-row Drill for Turnips, &c., with Manure on the Flat or Ridge.*—It is a cheap and efficient machine for drilling turnips, mangold-wurtzel, &c., with rape-cake dust, guano, Irish peat charcoal, or any light pulverised material. It is calculated for two rows from 20 to 28 inches apart, or three rows at 16 inches apart, and the quantity of seed may be delivered as required—say, for turnips, 1 to 6 lb. per acre; and beet seeds, 3 to 8 lb. per acre — the former being delivered by the action of brushes, and the latter by a revolving barrel. The

quantity of manure may be regulated from 2 to 24 bushels per acre.

This machine comprises most of the important features of the more expensive implements. It is 4 feet wide, and 36 feet 8 inches high, and weighs about 3 cwt. The cost does not exceed 13*l*.

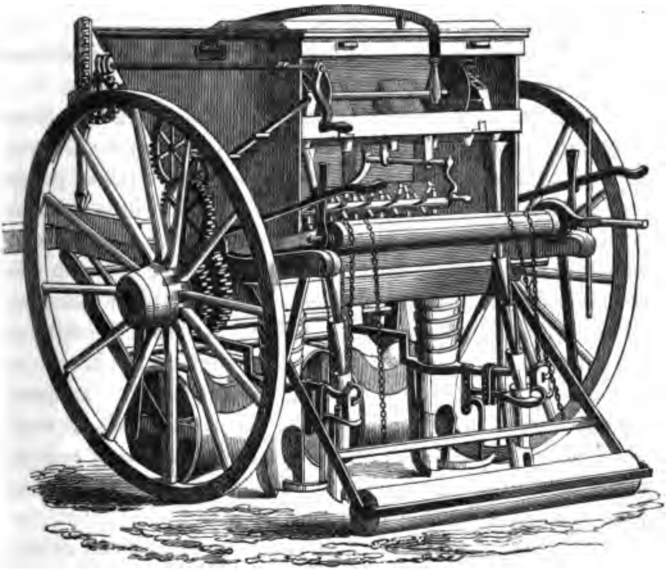
*Hornsby's General-purpose Drill.*—This is an efficient machine, having been much improved by Messrs. Hornsby in the manner before alluded to—that is in the plan of adjusting the box on sideling ground, in the substitution of India-rubber tubes for the old tin conductors, the regulating the supply of seed from the seed to the delivery box in the swing steerage, and in a great variety of other minor details. It is capable of drilling every kind of seed and corn, with or without manure, in any required quantities, and at any distance apart. Both seed and manure can be regulated while the drill travels. The agitator in the manure-chamber is so arranged that the man who follows can, by simply moving a lever, put it in or out of action without stopping the progress of the machine.

An improvement has been also made by having two coulter bars, by which arrangement the weights upon the ends of the levers have exactly the same pressure upon every coulter, thereby depositing the seed at an uniform depth.

Messrs. Hornsby, like Messrs. Garrett, manufacture every other description of drill, adapted to large or small farms, for the various kinds of seed and methods of sowing. Fig. 23 represents the *Two-row Ridge Drill* by this firm, which received a prize at the Great Exhibition of 1851. It has adapted to it various improvements for regularly delivering both seed and manure, the same as in the general-purpose drill; and equal facility is afforded for altering the quantity of manure it is depositing as it travels forward. The manure coulters are placed before the concave rollers; the ridges

are then brought into the proper form, and the seed is

Fig. 23.



deposited and followed by the second rollers, leaving the ridges perfect.

## HENSMAN'S DRILL.

This is often called the Bedfordshire drill; it was originally invented by Robert Salmon, of Woburn, but has been much improved by other parties since—first by two brothers named Bachelor, machinists, residing at Lidlington, near Bedford, and by Smith, of Kempston, but more particularly by Mr. Hensman.

It is an efficient little implement, but is not adapted to the variety of purposes that the other kind of drills are.

A modification of this is constructed by William Hensman & Son, of Woburn, who received a silver medal for it at the York meeting, in 1848, and a prize medal at the Great Exhibition.

This machine has several peculiarities, in which it differs materially from the generality of other drills. *First*, that the carriage rests upon the coulters instead of the coulters hanging from the carriage: the coulters are similar in form to a skate, and are in consequence very effective in penetrating hard ground, and in giving a firm bed to wheat sown in soft. The axletrees are made to slide, so that the wheels can be set to any width. *Secondly*. In the manner in which the seed box, &c., is supported between two standards, which give great facility for balancing it. A lever is placed through an aperture in the centre of the box for striking the barrel in and out of gear, and a very ingenious contrivance is adopted for adjusting the varying length of the driving shaft. A seed box is made to fix on the corn box, for the purpose of sowing clover and other small seeds broadcast at the same time as barley is being drilled; or it may be attached without the corn box, and used for sowing turnips or other small seeds; or it may be converted into a horse-hoe, by attaching hoes to the levers instead of coulter shares.

### HORNSBY'S DRILL FOR SMALL OCCUPIERS.

This is a very simple and cheap machine, and well adapted to the wants of small occupiers; it is made to work on the ridge, and deposit turnip or mangold-wurtzel seed, with or without manures; it may be fitted with rollers before and after the manure coulter, with a double-actioned lever. The manure and seed coulter act independently of each other; the manure can be deposited deep, and covered, and the seed at a shallower depth, as in the large and more expensive

implements. Two-row ridge-drills of the same character are also made by the same house.

Fig. 24.

HORNSBY'S DRILL FOR SMALL OCCUPIERS.

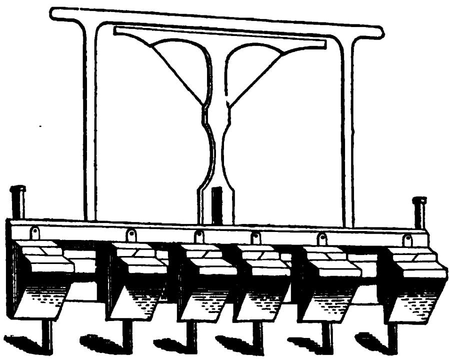
## DROP DRILLS.

Of these several varieties exist; they are for the purpose of depositing the seed in patches, and fixed intervals apart, and more resembling the action of dibbling than drilling. They are constructed in many respects similar to ordinary drills, but with this difference, that they have at the bottom of the delivery-spouts a chamber containing a valve, which regulates the egress of the seed in the manner before described.

## SEED MACHINES

Are long triangular-shaped boxes, having a small shaft running through them; upon this are fitted a number of little brushes, which, as they revolve, force the seed through apertures in the fore-side of the box, which is carried on a small barrow, on which it is laid crosswise.

Fig. 25



DIBBLING MACHINES.

It is the general opinion of the best judges that dibbled crops are much superior to those drilled, but machines for effecting this desirable object are by no means in such a state as could be wished, although many ingenious and really useful machines have been invented and constructed by different individuals ; amongst the most prominent of whom is the gentleman whose hand-dibbling machine we have engraved.

In the *Journal of the Royal Agricultural Society*, is a report of Newberry's dibbler. The judges say, "We have examined the effects of Mr. Newberry's dibbling machine, and have no hesitation in reporting the superiority of the wheat crops where the seed had been planted by that instrument, over those which have been sown broad-cast or drilled." We must not omit mentioning the very ingenious machine exhibited at the Great Exhibition, called the walking dibbler.

## CHAPTER VI.

### REAPING MACHINES.

UPON no implement (of late years) has so much attention been concentrated as upon reaping machines. There have been trials in almost every country; while newspapers, who seldom condescend to notice the progress of agricultural mechanics, gave whole columns to the reports of them, practical farmers paid the greatest possible amount of attention to the subject, offered every facility for the trials, gave judgment upon their respective merits, with a candour and fairness that does them infinite credit.

The great excitement (for it arrived at that), about reaping machines was in consequence of the success of two exhibited by Americans, named M'Cormick and Hussey, and who, I believe, might have exhibited anywhere else, again and again, without notice; but nothing in the Great Exhibition of 1851 escaped proper notice, great or small; whether it was the ponderous 68-pounder cannon of the Low Moor Iron Company, or the minutest portion of the machinery of a watch, it was sure to be seen, appreciated, and talked about by those who were interested in it: and the general public, who seldom trouble themselves about what does not immediately concern them, made up their minds in this case to examine everything, and try to understand them, if possible. Ladies were seen underneath locomotive engines, examining cranks, connecting rods, and eccentric gear, on one side of the building, or hurting themselves and damaging their clothes with spiky rollers, harrows, grubbers, scarifiers, and

pulverisers, on the other. Not a little either was due to the *Times* newspaper who, in much over-praising the American productions of reaping machines, and a fast-sailing yacht, calculated on giving a hard rub to the supineness of their special friends the farmers and shipowners: and in the case of farmers they were perfectly right—not in the superior ability of American mechanics, but in the shrewdness of that people in calling to their aid machinery constructed to cheapen the cost of agricultural operations; for, will it be believed, that the best reaping machine was invented in England many years ago, and although it was most regularly exhibited at Agricultural Societies' Meetings, and had premiums awarded to it, yet neither the farmers nor the agricultural implement-makers would have anything to do with it, and the thing was utterly neglected. I of course allude to Bell's machine, publicly exhibited in 1828. As a proof that little attention has been paid to this machine, I made some trifling experiments on a corn reaping machine in 1847, and was so led to see what had been done in the way of such machines. On meeting with an eminent agricultural implement-maker soon after, I inquired if he knew anything about reaping machines, and whether Bell's would at all answer in practice; he at once assured me that there was nothing of the kind in existence that would work half an hour without getting broken to pieces, and that Bell's machine was only an ingenious contrivance, but utterly worthless for any practical purpose, so I did nothing more in reaping machines. Six years after, at the Smithfield Club Show, in Baker Street, (that is, last Christmas,) I saw this same gentleman, and at once took him to look at Bell's reaping machine, made by Crosskill, of Beverley, and adopted by him as being on a better plan than any other, he being a maker of one of the American machines. My mechanical friend was obliged to admit, on my reminding him of our previous conversations, that he knew nothing about it, and

had only seen a print of it in a book, and thought it would not work, so took no further heed of it. This, I expect, is about the case with farmers and machine makers generally. The farmers set their face against new things, and the makers devote a much larger proportion of their time and abilities in puffing up and selling their goods than they do in endeavouring to improve them, and invent new ones to meet the new and improved systems of agriculture.

Reaping machines are by no means the recent inventions some persons imagine, as it is certain that machinery of some kind was used by the Romans for cutting corn, as frequent mention is made of them by the early writers; but whatever description of implement it might be, it certainly did not come into general use, nor was it introduced into England that I am aware of.

The first attempt at a reaping machine seems to have been made about sixty years since, by a person named Boyce; this machine was placed in a two-wheeled carriage, something resembling a cart, the axle revolving with the wheels. The cutting action received its motion from this, by a contrivance of wheel-work, and consisted of a series of scythes fixed to an upright shaft; these revolving horizontally, cut the corn, but left it lying in so rough a state that little advantage was got from it.

The next attempt seems to have been made by a London millwright, named Plunket; this was an improvement on Boyce's, as instead of cutting with scythes, he had a horizontal circular plate, jagged on the edge like a sickle. This was found to cut tolerably well, but was inefficient in other respects, and a better machine was constructed by a Scotchman named Gladstone, of Castle Douglas, in the stewartry of Kirkcudbright, the cutting principle being similar, but a contrivance added, by which the corn was collected and held in its place until cut by the circular revolving plate, and afterwards raked it off and laid it in patches upon the ground behind

the machine. Another feature in it was the placing a small circular wheel of wood covered with emery, this was kept in contact with the cutting wheel, at the opposite side to that employed in cutting, thus keeping the edge constantly sharpened.

That ingenious person, Salmon, of Woburn, next tried his hand at a reaping machine, and adopted an entirely new principle, for it should be remembered, before his time all the machines cut by a revolving circular plate, or disc, or scythes. *Salmon was the first to apply the cutting action of shears*, which appears to be the best principle, as the approved modern machines are so constructed, his reaper also laid it down in parcels as it was cut.

## SMITH'S REAPING MACHINE.

This was designed by J. Smith, of the Deanstone Works, Perthshire, whose name is now very familiar in agricultural matters. This machine consisted of a circular drum, upon the lower edge of which, projecting from the periphery some inches, was a cutting blade; the drum and cutter were placed upon an upright shaft, fixed to the fore-part of the carriage of the machine; this was supported by two wheels fixed to the axle, on which were placed bevil gear acting upon a horizontal shaft, which drove the drum and cutter.

The drum received the stalks of corn upon its surface, and being some distance round, were thrown off in a regular row. The machine was propelled by two horses, attached to a pole in the rear of the machine, the horses pushing it in front of them. It cut an English acre in about an hour, during which time the cutter required to be sharpened four times with a scythe stone.

Mr. Smith persevered with his machine from 1811 to 1815, but at last abandoned it, having too great calls upon his time in other directions.

## BELL'S REAPING MACHINE.

We come now to a very important point in the history of reaping machines, that is, the invention of the Rev. Patrick Bell. It appears that this gentleman's attention was drawn to the subject of such machines while at Cambridge, and that some years afterwards he constructed one for his own use. This machine was tried at Powrie, in the county of Forfar, in 1828, and its capabilities witnessed by a large number of persons. About fifty gentlemen and farmers, all interested in agriculture, signed a declaration, stating that the machine cut down a breadth of 5 feet at once, was moved by a single horse, and was attended by from six to eight persons, to tie up the corn, and that the field was reaped by this force at the rate of an imperial acre per hour.

In September, 1829, this machine was tried in the presence of a still greater number of persons, at Monckie, in Forfarshire, who attest that in half an hour it cut half an English acre of a very heavy crop of oats, which were lodged, thrown about by the wind, and exceedingly difficult to harvest.

It was tried in a number of other places in Forfarshire, Fifeshire, and Perthshire, and the general conviction appeared to be, that it would soon come into as general use as the threshing machine. But this was not the case, for nothing more was heard of it (except in its immediate locality, where, I believe, it continued to be used for some years,) until 1851, when the Great Exhibition of all Nations, as I have before mentioned, drew attention to machines for reaping corn. So slow had been the introduction of new machines, that, although this valuable implement had been invented in Scotland for twenty-three years, not one person south of the Tweed, that I ever heard of, had adopted it, and but very

few ever knew that such a thing had been invented. A few attempts had, it is true, been made during this time in England, but not with success, and all these were upon the horizontal disc plan.

To describe Bell's reaper, so as to be understood without a drawing, is almost impossible, and the limits of this book, and the number of cuts already given, prevent my giving one; but those who desire to learn more of the matter than they will find in these pages, will find a good description, with illustration, in "Loudon's Encyclopædia of Agriculture."

Bell's reaper consisted, in its original state, of a square framework of wood, forming a kind of carriage, which was supported on two broad-tired wheels of good diameter. The axle upon which these wheels hung passed through the machine, the wheels worked loose upon it; but, by means of clutches at each end, the wheels could be made to give motion to the axle when required. The lower part of the framing projected forward some distance, and was supported at the end by two solid wooden wheels of much smaller diameter than the principal ones. In front of these wheels, and attached to the carriage by iron arms, was fixed a bar of wood, called the "fixed bar," and upon this was screwed a row of triangular blades, something like (in shape) to the pointed blade of a pair of scissors, and called the "fixed cutters." Between the machine and this outer fixed bar was another bar, upon which were placed a row of blades, or cutters, similar to the others, except that they were lengthened by a piece of iron reaching from the outer fixed bar to the inner or movable bar. Between each o. the fixed cutters was placed one of those movable, and secured by a pin to the fixed bar.

Upon the axle of the carriage was placed a cog-wheel which, with other gear very ingeniously contrived, gave motion to the inner bar, causing the movable cutters to pass from right to left, and left to right, over those that

were fixed, thus producing a cutting action similar in every respect to a pair of shears.

Projecting from the machine at the top and over the cutters was another framework of a light character, and upon this was placed a light reel, formed by placing a flat spar of wood from one extremity to the other, of two arms which projected from a light spindle, the two ends of which were supported on either side of the projecting framing; as there were twelve of these arms, there were consequently six vanes, or wings, to the reel. The use of this was to press upon the mass of standing corn, and hold it steadily up to the machine while it was being cut by the cutters below.

This reel was made to revolve at a moderate speed by means of bevilled gear, worked from the wheel on the main axle to a small shaft, in the end of which was a pulley, which gave motion to a corresponding one on the end of the reel by means of a gut-line, or strap. From the outer end of the projecting lower frame-work to the end of the principal upper frame, were placed on either side two solid wooden rollers, thus forming an angle with the ground of about forty-five degrees. An endless cloth passed over these two rollers, and as they revolved (by the action of an endless chain passing round two pulleys, one at the bottom of each), the wheat, after being cut, was carried away to the side, and deposited in a row by the side of the machine.

Such is a slight description of this ingenious implement. All the different circumstances under which the machine may be used have been provided for by its ingenious inventor, and the machine had been brought to a point of perfection that is quite astonishing, considering that this was nearly the first attempt at a machine that performed all the necessary operations, and was actually the first in use upon the shears' principle.

Nothing much was done in reaping machines from this

time (1830) until 1850, with the exception of some attempts by Mr. Hornsby, and by Smith, of Deanston, but they were only experiments.

For the Royal Agricultural Society's show, held at Exeter, in 1850, the enterprising firm of Garrett & Son, of the Leiston Works, Saxmundham, Suffolk, prepared a machine for reaping corn, and took it to Exeter, but through some informality it was not admitted.

This machine was the invention of Obed Hussey, of Baltimore, U. S. A., and was the first American machine introduced into England. The plan of it was suggested to the manufacturers by J. Tolemache, Esq., M.P. for South Cheshire. This gentleman had seen the machine at work in America, and was so struck with its merits as to advise the Messrs. Garrett to commence the construction of such machines for the use of English farmers. The result of this advice was the production of the machine taken to Exeter, and called by the makers the Tolemache Reaping Machine. The next year (1851) brought forth the Great Exhibition, and this machine was taken there by the manufacturers, and placed among the various machines at their stand.

In the American department, there had also been placed two other reaping machines—one invented and exhibited by M'Cormick, and the other by Obed Hussey. We will now proceed to describe these machines, and the trials made of them separately.

Fig. 27 represents the side elevation of M'Cormick's machine; fig. 26 the plan of the same, and fig. 28 enlarged parts to show the cutting action more clearly.

## M'CORMICK'S REAPING MACHINE.

The best possible description of this machine is the specification itself.

Fig. 26.—Plan.

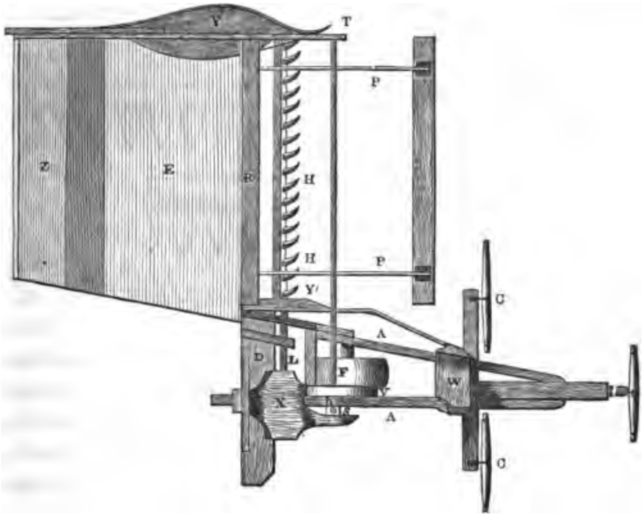



Fig. 27.—Elevation.

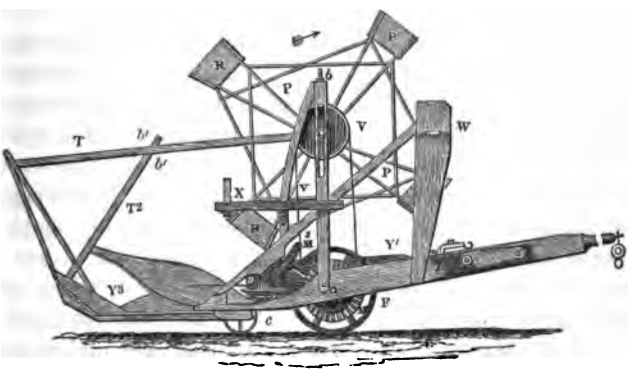
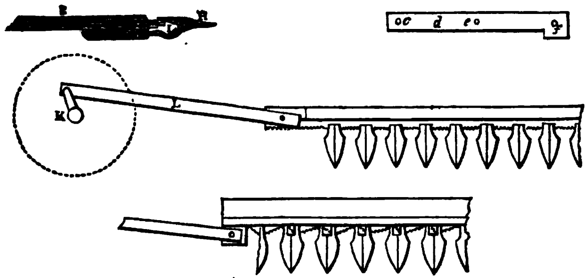


Fig. 28.



" SPECIFICATION.

" This invention has special relation to that class of machines which are worked by horses in cutting or reaping wheat, corn, or other grain, and has for its object the better holding of the stalks of the grain in a favourable position, while being cut and the more conveniently arranging, collecting and disposing of the same when cut.

" Fig. 1, is side elevation, and fig. 2, a plan of a reaping machine constructed according to the said invention ; A A is a frame of wood of a triangular form, to the front of which there are fixed the pole B, and whipple-trees C C. The back rail D, of the frame is prolonged on one side of the machine, so as to project about six feet beyond the frame, and the projecting portion forms the basis of a platform E ; F and G are two wheels upon which the machine is mounted. The wheel F (from its position) bears the greater portion of the weight of the machine, and is employed for communicating motion to the moving parts, as afterwards described. H H H, are a set of fingers somewhat of a spear-head shape, which are affixed to the front edge of the platform, and placed at regular intervals apart from each other. Immediately underneath these fingers is placed the cutting blade I, which is formed of a thin plate of steel, toothed upon its front edge and fitted

into a groove, or into bearings attached to the front of the platform. Fig. 3 is a cross section of the rail D, and the cutting-blade I, showing the method of attaching the fingers H H to the front of the platform, and their relation to the cutting-blade. This blade has perfect freedom to slide from one side of the machine to the other, but the amount of range given to it is limited by the crank K, to which it is attached by means of a connecting rod L; M 1, is a bevil wheel which is keyed to the shaft of the wheel F, so that both may revolve together and give motion to a bevil pinion. M 2 and wheel M. 3, which are fixed to an intermediate shaft N. The wheel M 3, gears into a pinion O placed on the crank shaft and consequently gives motion to the crank K, the connecting rod L, and the cutting blade I. The number of teeth of the intermediate gearing which has just been described are so proportioned and adjusted that the cutting blade may reciprocate and do its work very rapidly; P P is a large reel or gatherer, which is of very light construction, and carries at its extremities four blades R R R R, made of thin deal. At the near side of the machine this reel is supported by an upright S, and at the off-side by a brace T, which is raised upon the back of the platform. When the machine is going forward, the reel is made to revolve in the direction indicated by the arrow, by means of a band or belt U, which takes on to the hem of the bevil wheel M and the rigger V, the latter of which is keyed to the reel shaft. The distance of the reel from the platform is capable of being adjusted by means of the sliding bearing (upon the near side of the machine) which is acted upon by the screwed rod *b*. At the further side the brace T is fixed to the spur T 2 by means of a movable bolt, so that the brace may be raised or lowered at pleasure, by passing the movable bolt into any one of the holes (*b' b'*) further up or down in the spur. W is a seat for the driver, and X a seat for the person gathering the reaped grain from the platform.

"When the machine just described is applied to the cutting of wheat or other grain, it is brought to the edge of the field (with either two or four horses yoked to it) and with the platform placed in front, and the horses alongside of the crop to be cut down. As the horses advance, the wheel gearing is put in motion, which causes the reel slowly to revolve, and so prevent the straws or stalks from being pressed forward when they come in contact with the cutting-blade, which has at the same time a rapid reciprocating motion imparted to it by the action of the crank K and connecting rod L; the straws or stalks are thus speedily cut through, and fall backwards on the platform. The fingers H, H, H, greatly facilitate this part of the operation, as they hold the straws or stalks from yielding along with the lateral action of the cutting-blade; and it is for the more effectually accomplishing this object that they are formed of a shape like to a spear-head, which causes the straws or stalks to slide into the spaces between them when in that position, and as the inclined edges at the roots of the fingers (that is, immediately over the cutting blade) form an acute angle with the edge of the knife, the cutting through of the straws or stalks is sure to be effected by the reciprocating movement of the knife-blade. Two separate views of parts of the fingers and cutting blade are given in figs. 4 and 5, the blade in fig. 4 is straight in the cutting edge, while that in fig. 5 is zig-zag, or of an indented form."

## HUSSEY'S REAPING MACHINE.

*As Manufactured by Garrett.*

This is the implement before alluded to, as having been copied by Messrs. Garrett more than a year before. The cutting action in this is quite different from that of M'Cormick's, and may be considered a modification of Bell's. The corn is cut by a series of triangular knives, placed on a

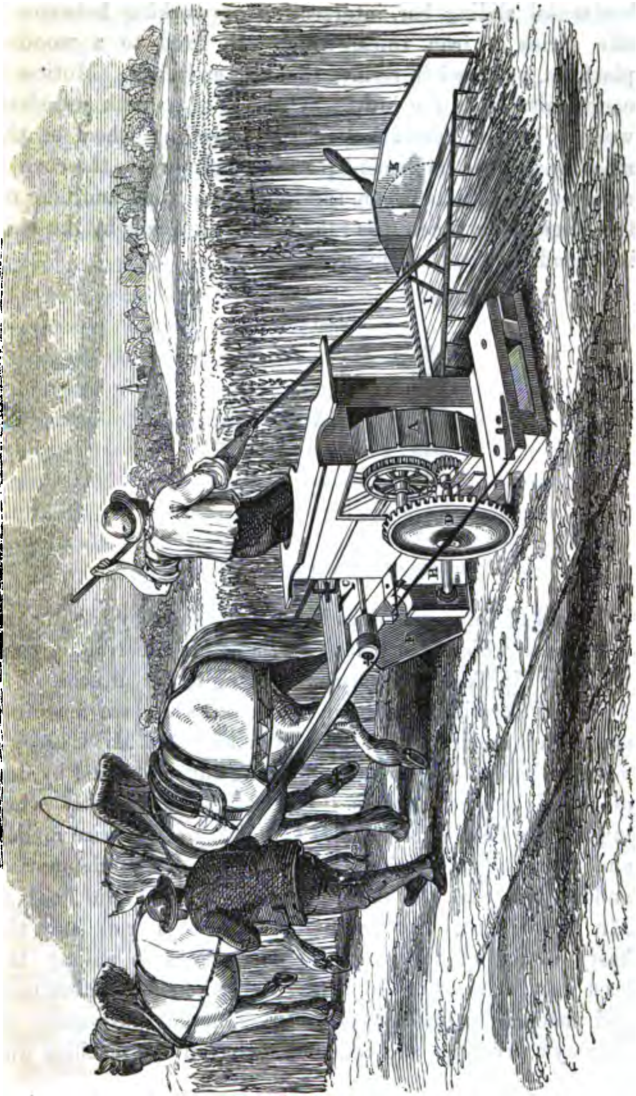
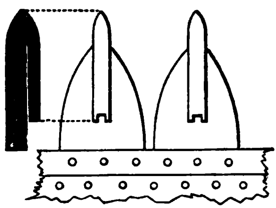


Fig. 29.—GARRETT'S REAPING MACHINE, UPON HUSSEY'S PRINCIPLE.

horizontal sliding bar, intersecting or working between a like series of iron tines, which are fixed to a wooden platform, provided to receive the corn as it falls. Motion is communicated to the knives by means of a crank and shaft worked by the revolution of the travelling wheel of the machine; as the implement proceeds in its work, the corn is received and cut between the knives and tines and falls on the stage, from which it is raked off at intervals by the man in attendance for that purpose.

Fig. 30.



CUTTERS OF HUSSEY'S REAPING MACHINE.

A trial of these machines being decided on by the jury of the class to which they belonged, they were accordingly conveyed to Tip Tree Hall farm, belonging to Mr. Mechi.

Mr. M'Cormick was there to attend to his own machine, and work it under his own superintendance, but Mr. Hussey's machine had no such advantage, being superintended by one of the Exhibition porters. The result was exactly what might have been expected: M'Cormick got the prize medal, and a vast amount of credit, and Hussey's condemnation and neglect that it did not deserve; in fact, the trial at Mr. Mechi's was not worth the name of a trial, and the hasty award of the medal to M'Cormick is among the least just decisions of the juries; nevertheless, practical men and machine manufacturers were generally favourable to Hussey's principle, and considered that, if the machine was

not then in a perfect state, it was capable of being easily rendered so.

Mr. Hussey at length arrived in England, to attend to his own invention, and the thing quickly began to assume another complexion, in consequence of which Messrs. Dean, Dray, & Co. of Swan Lane, London Bridge, made some arrangement with Mr. Hussey for the right to manufacture his machines in England. Mr. Crosskill of Beverley undertook their manufacture, and these machines having achieved some successes that got noised about, Messrs. Burgess & Key of Newgate Street placed in the public papers the following challenge:—

"Public Challenge to Makers and Vendors of Reaping Machines.—We the undersigned agents for Mr. M'Cormick, having observed sundry advertisements and circulars complaining of the decision of the Jurors of the Great Exhibition of 1851, in favour of Mr. M'Cormick's reaper, and of the reports given in the public journals of the trials which led to such decision, do hereby give notice to Messrs. Wm. Dray & Co., Messrs. Garrett & Son, Mr. O. Hussey, and all other makers and vendors of reaping machines whatsoever, that M'Cormick's Reaper will be tried at the Cleveland Society's Show at Marton, Middlesborough, near Stockton-on-Tees, on the 25th inst, and publicly challenge them, or any of them, to meet us there with their machines, for the purpose of a comparative trial of the respective merits of each, to be determined by the Chairman and Council of the Cleveland Society, or by such judge or judges as the said Society may appoint.—Burgess & Key, 103, Newgate Street, London."

The challenge was immediately accepted, and both it and the reply extensively circulated.

"In answer to an advertisement which appeared in the *Times* of the 18th, from Messrs. Burgess & Key, giving us a public challenge to a trial of the American reaping

machines, we hereby announce that we shall willingly accept the same, and on the 25th inst. shall be prepared, at the Cleveland Society's Show, Marton, Middlesborough, near Stockton-on-Tees, to prove to the agricultural world the superiority of Hussey's Reaper, for general farming purposes. We stipulate, however, that the machines shall be tested, not only on a particular patch of good upstanding grain, where they might perhaps prove equal, but on an average variety of condition, as to short and laid corn, &c., such as a farmer will usually meet with. Its capabilities for cutting green crops, such as clover, &c., shall also be proved. It must be evident to the farming public that the reaping machine which will cut a crop of the greatest variety and difference of condition must possess the greatest merit. —Wm. Dray & Co., Agricultural Implement Warehouse, Swan Lane, London Bridge."

Accordingly, the matter was arranged, and the following gentlemen were called upon to act as jurors :—

Henry Stephen Thompson, Esq., of Moat Hall, foreman; Mr. William Lister, of Dunsa Bank; Mr. John Booth, of Killerby; Mr. John Parrington, of Brancepeth; Mr. William Wetherell, of Kirkbridge, Darlington; Mr. Robert Hymers, of Marton; Mr. Christopher Debson, of Linthorpe; Mr. Robert Fawcitt, of Ormsby; Mr. Joseph Parrington, of Cross Beck; Mr. John Outhwaite, of Bainesse; Mr. George Read, of Hutton Low Cross; Mr. Thomas Phillips, of Helmsley; and Mr. Thomas Outhwaite, of Bainesse.

The following were the conditions to be submitted to by the representatives of the respective machines :—

The machines to be tried on wheat and barley, in such order and for such length of time as the jurymen may direct. The jury to have full power to use any means they may deem advisable in order to put the machines to the severest trials. The jury, in deciding on the merits of the two machines to take into their consideration,

1. Which of the two cuts the corn in the best manner. 2. Which of the two causes the least waste. 3. Which does the most work in a given time. 4. Which leaves the cut corn in the best order for gathering and binding. 5. Which is the best adapted for ridge and furrow. 6. Which is the least liable to get out of repair. 7. Which at first cost is less price. 8. Which requires the least amount of horse labour. 9. Which requires the least amount of manual labour. And whichever of the two machines so tried and tested has in it combined the greater number of the above qualifications, according to the opinions of a majority of the jury, it is to be pronounced the best implement. The trial which took place is thus described in the *Gateshead Observer* of the 27th ult.:—

"Great interest centered in the Middlesborough Agricultural Meeting of the present week. Mr. Philip Pusey, M.P., observed indeed to one of his northern friends, that the people of Cleveland could not feel more deeply interested this year in their own meeting, than did the agriculturists of England generally—a fact attributable, first, to the intention of Mr. M'Cormick's agents, Messrs. Burgess & Key, of Newgate Street, London, to exhibit his American reaping machine at the Marton ordeal. Secondly, to the challenge which they had given to Messrs. Dray, Hussey, & Garrett, to meet them in the field; and, thirdly, to the acceptance of that challenge on the part of 'Hussey's American Reaper,' by the inventor's agents, Messrs. William Dray & Co., of Swan Lane, Upper Thames Street, London.

"It was expected that the competition would have attracted a brilliant company to the ground, and so without doubt it would have done, had the elements been propitious; but the climate of England, proverbially fickle, attains its wayward maximum in Cleveland; and thus it happened that a drought of unusual duration (extending to three months) chose to terminate on the very day appointed for the competition,

and celebrated its breaking up by an outburst of rain, such as is seldom witnessed, even under the Yorkshire Hills. The drought had left the land so hard that the ploughs could not be tried, and the rain marred, to a considerable extent, the trial of the remaining implements.

"Despite the weather, however, there was a considerable muster at the appointed place—the farm of Mr. Robert Fawcitt, an agriculturist who combines science with practice, in the neighbourhood of Marton and Ormesby, his fields fronting the lodge-gates of Sir William Pennyman, Bart.

"We observed amongst the company several of the leading gentlemen and farmers of the district; and Mr. Counsellor Addison was present as a 'spectator.' After the trial of various implements, the reaping machines were tried; of fair weather there was no prospect, the only change was from foul to fouler, and foulest. It was now in the second degree. The implement jury left Mr. Fawcitt's with other farmers, and moved off to a field of wheat, where the rival 'reapers' were standing side by side. Mr. M'Cormick's machine was described in our last number. Mr. Hussey's is less complex in appearance. There is a seat on one side for an attendant, elevated above a level platform. The cutting machine mows down the wheat, and it falls back upon the platform, whence the attendant casts it on the stubble behind, and the labourers bind it into sheaves, and stack it. Mr. Hussey, the inventor, was present, and so also were representatives of the firm of Dray & Co., likewise Mr. Crosskill, of clod-crushing celebrity. It was curious to see on the soil of a Cleveland farm two implements of agriculture, lying side by side in rivalry, respectively marked 'M'Cormick, Inventor, Chicago, Illinois;' 'Hussey, Inventor, Baltimore, Maryland,'—American competing with American on English ground! Mr. Hussey led off; an attempt was made to keep back the eager crowd, but their curiosity was irrepressible—they flocked in upon the machine, so that the

experiment could not be properly performed, nor could the jury duly discharge their duties. Police constable Thompson did his very best—he was all but everywhere at once; but what avails a police force of one strong, against a concourse of Yorkshire yeomanry and clowns? It was requisite that he should have recruits, and a body of 'specials' came to his aid, who succeeded in procuring some approach to a clear course. Mr. Hussey then took his seat anew. This machine cut down a breadth of wheat from end to end of the field. It seemed to us to do its work neatly and well. The wheat was cleverly delivered from the teeth of the reaper, and handed over to the binders by the rake.

"But the weather was now at its foulest, and we could make no nice examination of the work. A high wind and a driving rain cleared the ground more effectually than Police-constable Thompson and his 'specials.' The cry at the head of the field was 'the nearest way out.' The Cleveland rustics, weatherproof, laughed at the townsfolk, and jeeringly replied, 'Put yeer heads on t' croon o' t' fence, an' tope ower in tit lane!' Without quite performing a summerset, we cleared the hedge, and waited not to see the conclusion of the contest. We soon learned, however, that the stormy blast and the descending deluge had cut short the experiment. Mr. M'Cormick's machine, it was said by some, made no commencement of a trial. Others reported that an attempt was made, but the horses could not contend with the storm, nor could the machinery be brought into effective action."

The unfavourable state of the weather during this trial was considered to have prevented the judges forming a sound judgment upon the two machines, another trial was therefore fixed for the following Saturday, and the result was again in favour of Hussey. The machines were tested on a crop of wheat, computed at 25 bushels per acre, very much laid, and on barley at 25 bushels per acre, very short in the straw, and, if possible, more laid than the wheat. The jury,

taking the different points submitted to their consideration in the order agreed, reported as follows:—

"1. That it was their unanimous opinion that Hussey's machine cut the corn in the best manner, especially across ridge and furrow, and when the machine was working in the direction the corn laid.

"2. By a majority of eleven to one that it caused the least waste.

"3. Taking the breadth of the two machines into consideration, that Hussey's did most work.

"4. That Hussey's machine left the corn in the best order for gathering and binding. This question was submitted to the labourers employed on the occasion, and decided by them, as above, by a majority of 6 to 4.

"5. Their unanimous opinion that Hussey's machine is best adapted for ridge and furrow.

"6. This question was referred by the jury to Mr. Robinson, foreman to Messrs. Bellerby, of York, a practical mechanic of acknowledged ability, whose report is appended below.

"7. That Mr. Hussey's machine at first cost is less price.

"8—9. The jury decline to express a decided opinion on these points in consequence of the state of the weather.

"The trials took place on the farm of Mr. Robert Fawcitt, of Ormesby, near Middlesboro'-on-Tees, who allowed his crops to be trodden down and damaged to a very great extent, especially on the 25th, when, in spite of the storm, an immense crowd assembled to witness the trials.

"The jury cannot conclude their report without expressing the great pleasure they have derived from seeing two machines brought into competition that were able to do such very good work, and also at witnessing the friendly, straightforward, and honourable way in which the exhibitors of the respective machines met on this occasion.

"Signed on behalf of the jury,

"W. F. Wharton, *Foreman*."

*Mr. Robinson's Report on Question* 6.

"Having carefully examined both machines, and given the subject due consideration, I am of opinion that M'Cormick's reaping machine, as at present made, is most liable to get out of order.

"(Signed) THOMAS ROBINSON.

"YORK, *September* 30*th*, 1851."

The following letter, written by a person who witnessed the trials, and addressed to Messrs. Dray, may give a better idea of them than could be communicated in any other way:—

"STOCKTON-ON-TEES, *September* 27*th*, 1851.

"SIR,

"Having been in communication with you relative to the trial of your reaper against M'Cormick's, and feeling deeply interested in the introduction of new implements into this district—particularly one of so much importance as a reaping machine—I think it is not probably out of place in me if I give you the result of my observations during the two trials which have taken place. From the fact that M'Cormick's machine obtained the prize at the Great Exhibition (though I do not *pin my faith* upon awards made by agricultural and other societies), the letter of Mr. Pusey's in the *Royal Agricultural Society's Journal*, the various newspaper reports, &c. &c., it was natural for me to be predisposed in favour of M'Cormick's machine; indeed, Mr. M. had a prestige in his favour, which, of course, operated against the 'Little Hussey.' Previous to starting at Marton, on Thursday, the gentlemen representing M'Cormick's machine expressed themselves desirous of testing the machines early in the morning when the dew was on, believing that their machine would cut the grain, under such circumstances, and that yours would not. Well, on Thursday we had a deluge

of rain, the surface of the land was very soft, and the corn very wet. Everybody there was astonished to see your machine brought up the field at a trot, cutting its way to the admiration of all present; it not only cut to the leaning corn, but it cut across over the corn leaning to the left of the postillion (I presume I must call him). M'Cormick's machine then attempted to start (he made two or three attempts), but the attendant confessed it was impossible to do so. That there might be no mistake about it, your representatives proposed that their machine should go up again. The jury said, 'No! We are satisfied that your machine can cut it under the present circumstances;' and so ended Thursday's trial. That the public might have every opportunity of examining the machine, it was very properly, I think, brought into the show-yard on Friday, and, in the midst of a *pelting rain*, exhibited its movements to the public.

"As per arrangement of the jury, the trial was resumed this morning. On entering the field, the corn was found to be not sufficiently dry to cut; in fact, the jury decided to wait until the corn was in such a state that the occupier of the field considered it would be prudent to cut it without risk of injury from the tying-up. This, then, was *a clear test of the practical merits* of the machines. M'Cormick's machine started first, cutting the wheat leaning towards the machine. The crop was so much laid from the rains that the 'reel' was of no avail—indeed it was quite *inoperative;* however, the corn was fairly cut through. The stubble was not left so level as to be called good work, and it was not cut so near the ground as is usually the practice here with the sickle, or scythe; but I suppose the machine can be altered to cut lower. The sheaves were laid tolerably even for binding. It appeared to me that, to fill the office of raker-off, was no little difficulty—I mean that it required great exertion. Under some circumstances, the plan of raking off

from the side is a great advantage; then the rule, I believe, generally is to bind as it is cut.

"The machine sent by you was then set to work, and it must have been evident to all that the cutting principle is superior to the other machine. The stubble was left more regular in height, and it was cut much closer. If it had a fault, it was too close: there were no 'longs and shorts,' as a countryman observed. The sheaves, too, were laid more regular for tying-up. The jury then requested the machine to be tried cross over the corn, leaning to the left hand of the man driving; here, again, the work was very fair indeed —*far better* than the people present anticipated. To the astonishment of many, an attempt was also made to cut the wheat laid *nearly flat from the machine*, and really in some parts of the field it cut very fair, in others leaving the stubble very much too high. If the wheat had been quite dry, and free from weed at bottom, I believe that, even under such a very unfavourable state, the machine, if attended by a skilful attendant, would have cut and laid the corn quite satisfactorily.

"M'Cormick then made an attempt to cut across the corn leaning as described above—indeed the cut was along side that made by your machine. As the farmers present said, there was no 'sight in it,' the stubble was cut *so very irregular*; indeed, it was quite clear to my mind that the cutting arrangements of M'Cormick's machine are defective. It requires the straw to be *held to* the knife before it will cut it. It would be difficult to cut a *loose* hair with a very sharp penknife, but a pair of scissors rather blunt would cut it. This simile applies, I think, to M'Cormick's and Hussey's machines.

"M'Cormick's machine was then set to cut the wheat leaning from the machine, in the same situation as Hussey's. In this case there was a *complete failure;* indeed, the knives passed over the wheat, occasionally cutting off the heads. If

a doubt lurked in the minds of any one as to the merits of the two machines, this failure of M'Cormick's settled the point in favour of Hussey.

"A trial was then made on barley by Hussey's machine, and it cut very satisfactorily. Mr. Fawcitt took Mr. Hussey's seat to rake off the sheaves, which he managed very well. Some said he would soon beat Mr. Hussey himself.

"I had not an opportunity of seeing M'Cormick's machine at work on the barley, but I believe that it did not work so satisfactorily as on the wheat.

"I shall be happy to answer you any questions you may ask me on this subject. Wishing you the success you deserve in introducing such a valuable machine,

"I am, respectfully yours,

"JOHN PALMER."

Both M'Cormick's and Hussey's machines have since this period received many improvements; the former an arrangement for cutting closer to the ground than formerly, and Hussey's in an improved form of knife by Messrs. Garrett, which much improves its cutting action.

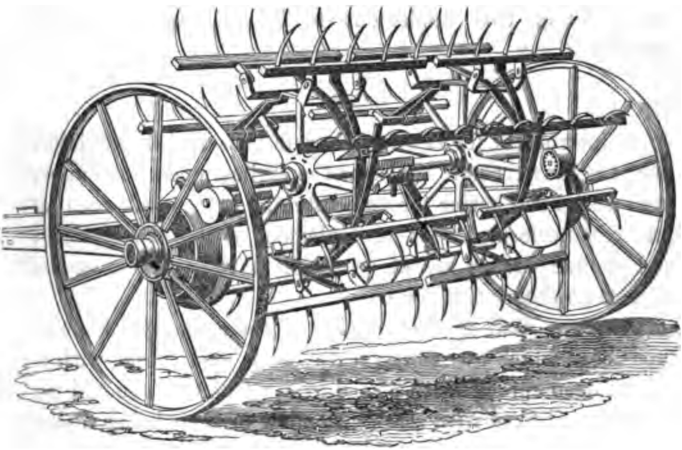
*Bell's Reaping Machine.*—In 1852, at the Smithfield Club Show, held in Baker-street, last Christmas, Mr. Bell's reaping machine was exhibited by Mr. Crosskill, who had made arrangements with Mr. Bell to construct it for him, and thus have the American reaping machines, about which there has been so much talk, been superseded by an English one invented thirty years before.

## HAY-MAKING MACHINES, OR HAY-TEDDING MACHINE.

This was invented by Salmon, of Woburn, about the year 1816, and has been modified and improved by several persons

since. Fig. 31 represents one of these machines as constructed by Wedlake, of Hornchurch, Essex.

Fig. 31.



It consists of a skeleton cylinder, with a series of rakes placed upon it, which revolve as the wheels of the carriage upon which it is placed move forwards. Wedlake's improvement consisted in making the cylinder in two parts, with motion independent of each other, and in so adjusting the teeth upon a spring-supported bar, that they yield to any sudden inequality in the ground, and immediately afterwards return to their ordinary position. An arrangement also exists for pushing back the implement without turning the rakes, and for raising them from the ground and keeping them there while the machine is travelling from place to place, or for a few seconds.

The tedding of hay is most efficiently done by these machines, and they are great favourites with the Middlesex farmers, and are extensively used in large parks in various parts of the country. They are manufactured by most

implement-makers, some having greater celebrity than others; among these, Messrs. Barrett, Exall, & Co., of Reading; Garretts, of Leiston; and particularly Smith and Co., of Stamford, who have made several improvements, which bring this implement to be an almost perfect machine.

## RAKES.

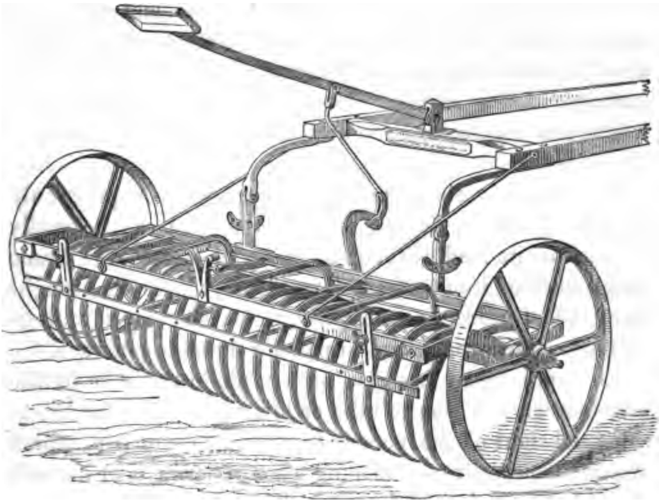
An instrument for raking the ground has doubtless existed from the most remote times, as the earliest operations upon land were little better than a scratching of the soil, such as might be performed with an implement of this description; and ordinary rakes are of so simple a construction as to require no description here.

*The Drag-Rake* is a larger kind of the ordinary rake, the cross head which carries the teeth being made large, with a row of deep curved teeth placed in it. The teeth should be of steel, and fixed with screws, to allow of their being easily replaced when broken out or injured. Sometimes wheels are placed at the ends of the cross heads, to render them more portable. When still further increased in size, they are drawn by a horse, and are in that state most valuable and useful implements, and much used on fallows to extract the couch grass and other rubbish, and in harvesting they are employed in raking up the loose corn, &c.

One of the earliest efficient implements of this kind is known as the Suffolk drag rake; it consisted of a row of prongs, supported at either end by wheels, and a simple apparatus, by which the prongs could be lifted up at once when required, but as the prongs were all fixed fast in the cross head which carried them, they were very likely to get broken, and in the modern improved horse drag-rakes this difficulty is entirely overcome, the implement having received a series of improvements from various persons, among whom Mr. Sayer of Bodham, Norfolk, and Mr. J. C. Grant of

Stamford, are conspicuous. Fig. 32 represents one of the best now in use.

Fig. 32.



HOWARD'S HORSE DRAG-RAKE

Is one of the best implements of this kind; a prize was awarded to it at Exeter, in 1850, by the Royal Agricultural Society, and again, it gained a prize at the Great Exhibition of all Nations. It is thus described by the makers: "It is intended for raking hay, corn, stubble, or twitch grass. The shaft irons are furnished with a joint and quadrant, by which the teeth may be readily altered, so as to rake upon their points, or set more or less off the ground. This method is to prevent the rake collecting the soil and rubbish with corn, an objection frequently raised against the use of horse-rakes; the teeth being curved or sickle-formed, are much stronger than when angular, and the hay and corn works round them

much more freely; the bar running under the teeth, and by which they are raised, is so arranged that the teeth do not, as in other rakes, rest upon it, but allow them to drop into any hollow parts of the land. The frame and teeth are made entirely of wrought iron; the teeth work independently of each other, so as to adapt themselves to the irregularity of the surface. It is mounted on high wheels, which are capped, to prevent the hay, &c., working round the axles.

By means of a simple pull-down lever, which requires only the strength of a boy to manage, the rake can be easily emptied of its load, without stopping the horse; the frame being made of iron instead of wood, the wheels are brought about a foot nearer to each other, which is a great advantage on narrow farm-roads, and in passing through gateways.

An improvement has also been made in this rake by the introduction of a plan to raise or lower the lower handle, to suit the height of the person employed to empty it, which avoids the necessity of stooping when relieving it of its load. This implement is useful in dragging meadows after a flood, and raking in clover seed in the spring.

*Biddell's Patent Corn-Gatherer* is an implement of unquestionable utility, as it much facilitates the operations of harvesting. It will enable a company of harvest men to begin loading when the corn is dry, without the usual delay, while corn is being raked into heaps, or, as they are called in Suffolk, "shocks," for pitching. In the busy time of harvest it saves manual labour, not only in gathering up swathes (without stopping the horse), but the corn when so gathered being compressed, may more readily be pitched, and a greater quantity be loaded upon a wagon, and got into the same barn room, than if raked together in the usual way. In the implements usually constructed for the above purposes, a great difficulty has been experienced in unloading, and it required the application of great strength to lift them

over the gathered heaps. One swathe is gathered at a time, and the load is left without its being lifted up.

It is constructed with three rows of tines, fixed to an axle, supported at either end by wheels. The tines are similar in shape to those of a horse-rake, and one of the three rows alternately begins to gather the swathe as soon as the previous one has finished its heap, the size of which may be regulated as required.—Messrs. Dean, Dray & Co., are the agents for the sale of the implement.

## CARTS AND WAGONS.

Carts, like most other agricultural machines, vary in their form and construction, according to the nature and peculiarity of the roads upon which they have to travel, or the particular character of load they are to carry.

That any advantage is to be got from using the old-fashioned heavy carts and wagons that are found in many localities, is a mistake; yet many farmers of my acquaintance still persist in purchasing these unsightly and abominable productions, made by village wheelwrights, who are entirely ignorant of the true principles upon which carriages ought to be made. Many of these old wagons and carts were perhaps tolerably well suited to the state of the roads in times far back, but, during the last 50 years, not only have the great turnpike roads which connect one market with another, but the parish roads also, been brought to an exceedingly good state, and it is now only the green lanes and farm roads (which depend upon the farmers themselves) that are to be found in a state such as to require the carriages that travel upon them to be constructed in such a cumbrous manner.

Great facility for removing manure from the steading, and carrying the produce of the fields back to the homestead, is now as necessary as the lands and buildings themselves, as

is also the means of conveying the produce of the farm to market; for it must be remembered always, that those great growers of corn in distant countries, with whom the English farmer has now to compete, have an immense advantage over him, in the facilities they possess in carrying their farm produce by water to distant towns and markets, as the site of many of the great American and other corn-growing districts is upon the banks of great inland lakes and large rivers.

We have no space in this little book to enter at length into the question of wheel carriages, nor can it be properly considered as part of the subject under notice.

That carts possess many advantages over wagons is now pretty generally believed, and is proved by the fact, that wherever any large amount of work has to be done, carts only are employed, as a horse, when drawing singly, will do half as much more work than when acting with another; as alone he has nothing but his load to contend with, whereas when two are pulling, a considerable amount of power is lost in their pulling in different directions, and more or less at particular moments. Three horses will certainly do more work in single horse carts, than four in two-horse carts, and when the work is regular, and along tolerably even roads, a great saving will take place with one and two-horse carts as compared with wagons with three and four horses, though for very long journeys, and peculiar descriptions of merchandise, wagons properly constructed may be preferable, but this case does not apply to the farmer. In Scotland one and two-horse carts only are used, and the same is the case throughout all the best cultivated districts of England. In shifting earth, and in the carriage of building materials, contractors and builders always employ one or two-horse carts, and never wagons. Harvesting may also be done with carts, properly constructed, better than in any other way.

Carts and wagons are now constructed by most agricul-

tural machinists, with every attention to strength and lightness, while the peculiarities of any particular locality are carefully considered, should any such exist. The formation of the wheels being the most important part of the cart or wagon, a factory has been established by Mr. Crosskill of Beverley and Liverpool for manufacturing his improved wheels; these are sold in sets to the local makers, who mount the cart and wagon bodies of their make upon them, and great benefit and superiority of the carriage is obtained; it being impossible for small makers to compete in price with Mr. Crosskill in the construction of wheels, where everything is done on a large scale, and the parts made with mathematical accuracy. Wheels of any size are made by machinery, constructed expressly for the purpose. They have iron naves, called balled naves. The arms are turned perfectly true by self-adjusting machinery, and after being case-hardened, are fitted complete to a wrought iron axle. The spokes are made of well-seasoned English oak, driven into the naves by a powerful machine, and then fitted into a lathe, for turning the end of each double-shanked spoke to fit into double-shouldered sockets, bored with equal precision in the felloes, which are of ash, sawn out, segmented, and turned by machinery. The hoop-tires are bent, cut, bevilled, fitted, and hooped in the same manner.

## CROSSKILL'S MODEL ONE-HORSE CART.

This is perhaps one of the very best specimens of a cart that could be found, and is particularly recommended, as a generally useful one, and adapted better than any other for the everyday wants of the farmer. They run exceedingly light and easy with heavy loads, and are equally well adapted for the farm roads as they are for those macadamised; everything is constructed with a view to economise materials, and acquire lightness without sacrificing strength. It is fitted

with the patent wheels, tire $2\frac{1}{2}$ by $\frac{1}{2}$, and every requisite for rendering it generally useful, while the price is not more than for one of the clumsy contrivances of the village wheelwright. About thirteen pounds is the price of one to carry 30 cwt., and fitted complete with harvest shelvings or staves.

They are made of a variety of sizes, to carry from 30 cwt. to 60 cwt. Some of them have strong springs, portable covers and seats, self-acting tailboards, &c.

## FARM RAILWAYS.

But little has at present been done towards the general introduction of farm railways; nevertheless some of the leading agriculturists have laid them down, and express themselves much pleased with the result.

Mr. Crosskill, of Beverley, has contrived a system of railway that is at once extremely cheap, durable, and portable, with turntables, points, and curved pieces complete; at once forming a most admirable substitute for the bad roads, lumbering waggons, clumsy carts, and teams of heavy horses that are always to be met with on English farms, only half loaded, yet up to their knees and axles in mud and earth, and doing but little work, while consuming much valuable time. The railway of Mr. Crosskill is constructed in lengths of 15 feet by 2 feet 11 inches wide, and 2 feet 6 inches in gauge; the ends fitting into iron sockets.

The rails are of wood (the best red deal), edged with iron, and strongly put together.

The trucks are made to carry about 10 or 15 cwt. of turnips, and are especially adapted for carrying manure, marl, lime, &c., and removing every description of root-crop.

It can be removed or laid down with the greatest facility, as two active boys will move it one hundred yards farther

on, and replace it, in less than ten minutes. To reduce the cost for delivery, by rail or vessel, the rails are packed up for delivery in packages 15 feet long, 12 inches square, and weighing $4\frac{3}{4}$ cwt.

Sets of ironwork only are supplied where parties may wish to use their own timber.

*Cost of a Portable Farm Railway, to carry* 15 *cwt. Loads.*

| | £ | s. | d. |
|---|---|---|---|
| 100 yards, or 20 lengths of rail at 2*s.* 6*d.* per yard | 12 | 10 | 0 |
| Truck with end tipper | 5 | 0 | 0 |
| Truck to tip on either side | 5 | 0 | 0 |
| 1 turntable | 5 | 0 | 0 |
| | 27 | 10 | 0 |

*Extras.*

| | | | |
|---|---|---|---|
| 2 sets of points with double rails 15 feet long | 5 | 0 | 0 |
| 2 sets of double rails to join the double lines, each 15 feet long | 3 | 0 | 0 |
| 2 turning curves to join a double line, each 10 feet long | 1 | 0 | 0 |
| 4 turning curves, to branch off the straight line | 2 | 0 | 0 |
| | 38 | 10 | 0 |

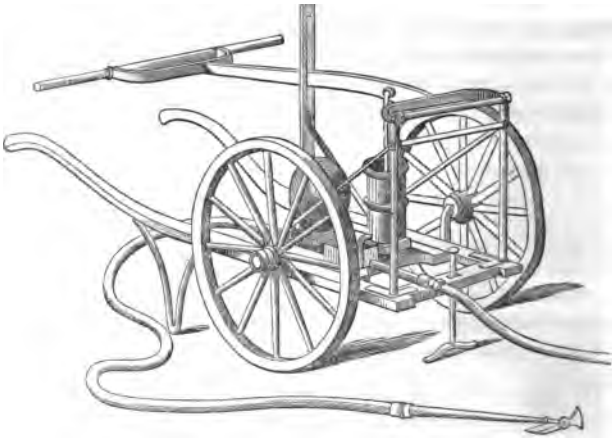
*Cost of a Permanent and Portable Farm Railway, to carry* 40 *cwt. Loads.*

| | | | |
|---|---|---|---|
| Mr. Crosskill will engage to lay permanent rails with wood sleepers, fitted three feet in gauge, including all materials and labour, except carriage and one man's travelling expenses, per yard | 0 | 5 | 0 |
| Portable rails with wood sleepers, in 12 feet lengths, fitted 3 feet in gauge, for two men to carry and lay down from the permanent rails across any part of the field, at per yard | 0 | 4 | 6 |
| A double line, with sets of points, curves, and entire connecting rails, about 55 yards run, at per yard | 0 | 10 | 0 |
| Sets of ironwork, for one 15 feet length, with dry nails, per yard | 0 | 2 | 6 |

| | £ | s. | d. |
|---|---|---|---|
| Sets of wheels and axles, for railway trucks, each set . | 3 | 10 | 0 |
| Turntables for gateways of any field, or homestead entrances . . . . . . . . . . . | 7 | 10 | 0 |
| Trucks to carry 40 cwt. of earth, manure, &c. . . . | 7 | 10 | 0 |
| Trucks with harvest frames, complete . . . . | 9 | 10 | 0 |

Cuttings, embankments, or any other earthwork to be done by the owners or occupiers of the land.

Fig. 33.



BADDELEY'S FIRE-ENGINE AND LIQUID MANURE PUMP.

This is an exceedingly efficient machine, answering both the purpose of a fire-engine and a pump for spreading or forcing liquid manure on the land. It is manufactured by Merryweather, of Long Acre, for the inventor.

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64